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JUNE 2013
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SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490. All material is copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $105.00 per year in Australia. For overseas rates, see our website or the subscriptions page in this issue.

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ISSN 1030-2662
Recommended and maximum price only.

Publisher's Letter

Lithium batteries set to take over

This month, we have two articles which reflect the present and future of battery-powered electronics. Rechargeable batteries such as sealed lead acid, nickel cadmium and nickel metal hydride are on the way out. They are rapidly being displaced by lithium batteries in their various versions: lithium-ion, lithium polymer and lithium iron phosphate ($LiFePO_4$). This process is already well under way with mobile phones, cameras, laptops and tablets. They are also being used in more heavy-duty applications such as portable power tools, electric cars and bikes and even as boat batteries. In boating applications, their much lighter weight is a big advantage, off-setting the much greater cost compared to deep-cycle lead acid batteries.

Stan Swan's article on $LiFePO_4$ cells gives the background on what is happening. These cells are lighter and more energy dense than nickel cadmium/hydride cells, they have more than twice the voltage and they can be more deeply and repeatedly discharged. Sure, they do have drawbacks but technology is rapidly adapting to those too.

In fact, on the power tool front, it has now got to the stage where you would definitely think twice about buying a tool which was not lithium powered; power tools with nickel cadmium/hydride batteries all too often succumb prematurely with a dead battery pack which is probably not economic to replace.

In recent months, readers may have noticed that we have designed a number of projects around lithium button cells instead of the more traditional 9V alkaline battery. While button cells are not rechargeable, they have the benefit of being a very compact power source which is becoming more and more usable because more chips are being released which work on 3V supply rails. A lithium button cell and its PC-mount holder also have the benefit of being cheaper than a 9V battery and its snap connector.

The most recent example of lithium power is this month's article on a compact mixer for PA systems, designed to provide a number of input permutations when extra inputs are not available on the PA itself. Ross Tester has a lot of experience in PA work and he refers to it as a "Lump In The Coax". That's an interesting variation on the old theme of a hifi amplifier being a "straight wire with gain".

So is the mixer equivalent to a "straight wire with gain"? You might think that an audio circuit involving a significant number of op amps running from a 3V supply would have fairly mediocre performance but using new devices designed for this type of application, it gives a very creditable account of itself. Furthermore, that lithium button cell can give over 200 hours of life. That's incredible when you think about it.

The final icing on the cake is that you can use a rechargeable lithium-polymer battery from a mobile phone. The mixer PCB has an on-board lithium polymer battery charger but with the capacity of these batteries, they could potentially give more than a thousand hours of service before needing a recharge!

Note that the overall concept of this mixer is really quite simple but by employing the latest rail-to-rail low-voltage op amps, combined with lithium power, a compact little performer has been produced. What can we come up with next? Given that mobile phones and tablets are galloping ahead with features and performance, the future looks really bright.

Leo Simpson

Download charges: *ever since SILICON CHIP has had a website, we have had a policy of making downloads for microcontroller software and PCB patterns available free. I regret that in these days of "user pays" we now have to apply a nominal charge for this service: $3 per item. The good news it that if you have a current subscription to SILICON CHIP – print or online – all downloads will remain free.*

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Australian railways still need upgrading

There is an urgent need, in Eastern Australia, to replace expensive air and road transport with something more efficient. Over the years, there have been a number of studies proposing fast rail networks to connect the main population centres.

The latest, commissioned by the Federal Government, was published in two phases: August 2011 and 11th April 2013. It was to determine the feasibility of a high-speed rail network, approximately 1800km long, linking the major centres along the eastern seaboard. Starting with Brisbane in the north, it was to take in Coffs Harbour, Newcastle, Sydney, Canberra, Albury, Shepparton and on to Melbourne. The time of travel, for an express journey, between Sydney and Melbourne was to be less than three hours.

The full report is an extensive academic study which cost about $20 million. In terms of detailed analysis and diagrams, the Government got good value for its money. The estimated cost of the project is $114 billion and the time for completion of the order of 40 years.

Of course, a rail link complying with this specification will never be built. No Government could or would put up the money nor would there be enough kind-hearted private investors with a spare $100 billion dollars odd to put towards the project. Besides, in less than 40 years, the present four foot eight and a half inch rail system, which was originally designed for 60km/h may be replaced with something more modern. There are already magnetic levitation systems in operation.

What is needed now is a specification for a rail system which could be completed in reasonable time and at reasonable cost. The most urgent need is for the link between Sydney and Melbourne, both cities with populations of over four million. Maybe the time of travel could be a little more than three hours.

Let us have a look at a specification for Sydney/Melbourne which may be within the budgets of State/Federal governments. The main cost may arise from the Blue Mountains west of Sydney and the best solution could be a tunnel, the total sections of which may be about 50km long. The link between Sydney City and the mountains could follow, mainly via the present route, with some sections straightened. Land acquisition would be minimal.

West of the mountains to Albury and a spur line to Canberra would need new tracks and the purchase of land. Most of the present line towards the south has steep curves and it probably could not be modified for high speeds. On the other hand, the link between Albury and Melbourne is fairly straight and over level country and it may be a matter of just upgrading the tracks.

How long will it be before the Government undertakes another study, this time with a realistic specification?

Maurie Findlay, MIE Aust, Badgerys Creek, NSW.

SILICON CHIP software should be open source

Your Publisher's Letter in the May 2013 edition, on whether microcontroller projects have too many features, certainly begs a response. Too many features? Well, yes and no. Your concerns seem to centre around software development rather than hardware.

I suggest that a reusable module approach is better than a product-in-a-box design like the CLASSiC DAC and that opening the software side of your projects to reader "tinkering" and enhancement is better than thinking of software as a necessary evil to be minimised.

I have had a view for some time that SILICON CHIP pushes the software/firmware aspect of its projects too far into the background. Microprocessors are now cheaper than individual transistors were when I started with this hobby. System-on-Chip devices are heading the same way.

Software is really the key to unlocking the potential of these devices for

Simpler projects wanted as well as the more complex

It's obvious from Sal Sidoti's comments, featured on page 6 of Mailbag in the May 2013 issue, that Sal is very experienced with electronics and constructing projects. However, I believe that SILICON CHIP should not only have advanced projects for persons such as Sal but should cater for all levels of electronics enthusiast.

While "getting with the technology", as Sal put it, is fine for advanced enthusiasts, we still need to consider the less experienced constructors and those just starting with electronics.

Someone just starting with electronics and learning the basics would be put off when confronted by a complex project involving surface-mount technology. The old "through-hole design" still has a place for simple projects and for less experienced constructors and those just starting out with electronics. Single-sided PCBs of less complex design are still an important consideration for those on a tight budget who make their own PCBs. It's just not possible to make a double-sided PCB with plated-through holes at home.

Personally, I would like to see more simple projects in the magazine, to cater for a wider range of electronics enthusiasts.

Bruce Pierson, Dundathu, Qld.

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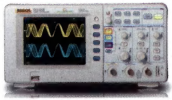

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Mailbag: continued

Troubleshooting intermittent faults in vehicles

That was an interesting story from J. H. about blowing a fuse in a modern vehicle (Serviceman, May 2013, pages 44-46).

The inability to pinpoint the exact time (or surrounding events) of failure is a feature of intermittent faults. The few seconds of delay between fuel-pump failure and engine failure was enough to confuse the issue. I wonder if, after a couple of failures, J. H. thought of wiring a lamp on the dash to show the exact moment of the fuse blowing?

I'm bemused by the dealer's decision to replace the transmission and that in this process no-one noticed the out-of-place fuel-pump wire that was causing the problem.

Earlier petrol Pajero 4WD vehicles had an interesting problem with the fuel-pump wiring; it lead through a recess under the back seat that housed the jack. If you didn't secure your jack and you were on rough roads a lot, the jack would vibrate around and eventually short the wiring. Unfortunately, a blown computer was the result, not just a fuse.

I'm sure there are similar problems with any brand, where there just aren't fuses or other self-protection measures in the right places to cope with any possible wiring short.

Kevin Shackleton,
Cottesloe, WA.

electronics hobbyists. However, software development by professionals is expensive and I fully appreciate that a specialist magazine cannot fund development of elaborate feature sets – but you probably don't need to.

The same edition features an article on the Raspberry Pi. The Raspberry Pi relies on software which would cost hundreds of millions of dollars to develop, almost all of it freely available and much of it developed by hobbyist programmers. That software already includes much of the "extra software functionality" in the CLASSiC DAC.

I suspect you can broaden the appeal of SILICON CHIP if you can find a way to become part of the open source software scene. After all, you are, in a way, part of the open source hardware scene. Even when you publish copyright designs, you are inviting your readers to learn, understand and even build for personal use.

I suggest that a DAC designed as an extension to a device like the Pi would look more like the earlier High Quality DAC or the Crystal DAC at the hardware level: a set of circuit board modules rather than an all-in-one. I for one have a use for such a design but I am primarily interested in the DAC output module, not the extensive input provisions of the CLASSiC DAC design.

I suspect that a high-quality DAC, intended as a peripheral for the Raspberry Pi (or the somewhat similar "Beaglebone Black"), would have significant international appeal, whereas the CLASSiC DAC may never even make it as far as a retail kit from your two main advertisers. Also, such a device might well be cheaper to develop – provided the basics work at publication, you could invite readers and the open source community in general to add software features as they see fit. Others might not be interested in the DAC but might value a way to add lots of TOSLINK and S/PDIF inputs to a Pi or similar controller.

I have similar thoughts about another complex, microprocessor-dependent project presented recently by SILICON CHIP. The February 2012 edition that carried the article on the "Crystal DAC" also contained an article on re-using SmartDrive motors, which I had expected would be about building a motor controller. Instead it urged readers wanting to experiment with the SmartDrive to buy a "black box", Chinese controller; not much to be learnt there. Then, the April 2012 edition carried the first article on building an Induction Motor Speed Controller. I was struck by the similarity between the basic operating principles of that controller and the design of an actual Fisher & Paykel SmartDrive controller.

So for me, though interested in the pool motor control application of the Induction Motor Speed Controller, as a hobbyist I am much more interested in whether the same basic design could be extended to function as controller for a variable-speed machinery motor using a SmartDrive. If so, a couple of extra hardware features would be needed, namely inputs for Hall-effect position sensing and provision for remote speed display and control.

Better still, the motor controller could itself be controlled by a component as sophisticated as a Raspberry Pi.

Peter Bennett,
Place, Macarthur, ACT.

Projects & products should be made simpler to use

Your Publisher's Letter in the May 2013 issue is right on (again). Your comments regarding over-complexity of designs are correct.

You will remember the development of VCRs, where all the bells and whistles reached an absurd level and consumers got so confused over the programming of them that finally some manufacturers produced a simple device that just recorded and played back programs.

It is a bit like the mobile phone. I just want to make and receive phone calls and SMS. I can wait until I get home to my lounge room to watch TV and all the other stuff that the new phones provide. No wonder every high spot in the countryside is bristling with antennas.

Keep up the good work on a really great magazine.

John Anwin,
Healesville, Vic.

Please keep projects simple

In answer to your question at the end of the "Publisher's Letter" in the May 2013 edition, may I register a "simple please" vote? My reason is best illustrated by my mobile phone. I need and want to do two things with it, receive and send calls, but it is capable of doing a myriad of extra things. Unfortunately, I can't lock them off so they can't be activated.

The result is that I frequently miss calls while I try to get the phone out of the function it has gotten into as I

extract it from my pocket. The simpler it is, the less that can go wrong and the easier it is to fault-find when things do go wrong.

Cliff King,
Taringa, Qld.

Lots of features in microprocessor-controlled projects please

Please keep lots of features in your microcontroller projects. Although I do not construct most of the projects, I almost always examine the source code for inspiration and exposure to different programming languages.

More features mean there is more code to examine and often the organisation necessary to incorporate the multiple features in a finite, small, code space is of greatest interest.

Perhaps some Python code for the Raspberry Pi will soon appear?

Bill Hanna,
Alice Springs, NT.

Recollections of the 32V era in South Australia

The letter from Brian Playne (Mailbag, March 2013, page 8) on this subject triggered some memories for me. During the 1950s, big changes were taking place in electricity distribution in SA under the Playford Government but many country towns were still dependent on locally-generated mains power. Outside the towns, rural properties still relied on small petrol or kerosene 32V lighting plants, installed when this "luxury" could be afforded.

Delco was a popular make and an advertisement in the Loxton show book in 1924 stated that there were 25 Delco models, each with a "Tudor" English battery (16 glass-jar 2V cells), and they claimed "675 units now sold in SA". The majority of the small Delco plants were for 32V installations. They were direct-coupled, air-cooled and could be "operated by children"!

During the 1930s, the depression, droughts and wartime shortages meant that some farm homesteads had to get by with kerosene lamps and candles but the more innovative installed small 12V systems for house lighting until economic conditions improved in the late 1940s, when they could upgrade to a 32V system.

The property owned by my great grandparents' family had a Phelps petrol-kerosene lighting plant installed in the early 1930s and I was captivated by the ammeter, sparking commutator and the bank of eight 4V deep-cycle batteries connected in series by lead straps and bolts.

Dunlite wind-driven 12V and 32V lighting plants were quite common too, particularly in coastal areas with reliable prevailing winds. Freelight (made by Hannan Bros) was another brand of wind plant but few if any survive now. Normal incandescent light globes ranging from 15W to 100W were available in BC or ES types, although 25W and 40W sizes were the most popular. There were no fluorescent lighting options available, except for 240VAC.

Besides providing electric lighting, early 32V installations could operate "luxury" items like electric fans, radios and vacuum cleaners (both upright and cylinder types). Then labour-saving appliances like washing machines

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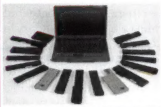

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Mailbag: continued

Excessive sound levels in gymnasium

I have just made an attempt to do some exercise at a gym here in Toowoomba. I had never been there before but I decided that I must do some regular exercise because, like many others, I am suffering from Type 2 Diabetes.

However, when I showed up for my first session I discovered that they like to have the sound turned up too loud for me, with some rather discordant noise otherwise called music. So I asked if it could be turned down a bit.

The answer from the staff and manager was NO. Reason was that if they turn it down a bit, then other people would complain and they couldn't face that. So the outcome was that I asked for my $100 membership fee to be returned, and it was. So now we have the situation again where our juniors just ignore our wishes and don't care at all for the loss of business.

The only way that I could win the argument would be to bring in a dB meter and try to prove that they were causing damage. Of course, I doubt that this was the case but I was not comfortable with the volume that they are using and the cacophony they were playing. All I want to do is exercise without being bombarded.

Chaim Lee,
Toowoomba, Qld.

Comment: again, we have a situation where people subject others to unnecessarily loud music. Some customers will stop going. Presumably, the rest will end up fit but deaf.

It's bad enough for older people but even toddlers and young children are now being subjected to excessive noise levels at concerts which cater to youngsters.

and water pumps (that used fractional HP DC motors) became more common and to balance the power consumed, the "engine" would be run on wash day while the washing machine was running. A 500W non-automatic iron would definitely require the engine to be running on ironing day to save the batteries!

The post WW2 "wool boom" contributed to domestic prosperity on farms, enabling a range of domestic home appliances to rival their city cousins! The Sunbeam Mixmaster with its many attachments was a status symbol in the 1950s modern farm kitchen and there were blenders, kettles and toasters too. However, any heating appliance, such as a kettle or toaster (rated at 550W) required the lighting plant to be running to work effectively, and preferably via a dedicated line from switchboard to a dedicated power point in the kitchen!

The farm workshop didn't miss out either, with a range of 1/4-inch and heavy-duty 1/2-inch electric drills available, complete with a matching drill press. Some very keen welders were able to purchase a 32V welder which used a set of heavy series resistances to control the welding current. There were reports of explosions in the battery room caused by badly maintained battery terminals when a welder struck an arc in the workshop!

By the late 1950s in South Australia, the Playford Government scheme to connect the majority of rural properties to the mains grid was firmly established. After a trial period on upper Yorke Peninsula, the Single Wire Earth Return (SWER) network gradually connected farms using a 19kV SWER network.

Farmers were happy to sign up and get a whole set of new 240VAC appliances. No more lighting plants to maintain or batteries to purchase seemed an attractive option and most were glad to see the last of them! The change to mains power resulted in a large workload for electricians rewiring buildings before connection and the redundant 32V equipment was often traded in and sent to more remote homesteads.

The SWER system continued to expand through the more closely-settled rural areas of SA during the 1960s, and by the mid-1970s, there were very few rural properties not connected to the grid. Since the 1980s, improved technology in power generation has enabled remote homesteads to generate reliable 230VAC power on-site, incorporating solar panels and power inverters, which only require a diesel plant for back up.

And so, since the 1980s, 32V DC equipment and appliances have virtually disappeared from farm clearing sales and whatever remains is in the hands of collectors who enjoy a small measure of independence from the grid and who (like me) enjoy reminiscing about the "good old days"!

Richard Wood,
Loxton, SA.

More doubts over GPS Timebase accuracy

I must side with Tuck Choy (Mailbag, April 2013, page 4) in doubting your accuracy claims for the GPS Timebase. Your test involving the Timebase and the GPS-Based Frequency Reference measures only the combined jitter of these units and ignores jitter in the GPS signal itself, as this is common to both units.

While the transmitted GPS signal is of very high stability, the propagation delay of the received signal is affected by temporal fluctuations and spatial variations in ionospheric electron density and by spatial variations in tropospheric water vapour content (the spatial variations are effectively scanned by the motion of the satellite). This is why differential GPS, in which a mobile GPS receiver is compared with a nearby fixed receiver in a known location, provides positions with several orders of magnitude better accuracy than is possible with a mobile receiver alone.

Tony Ellis,
Tithi Bay, Porirua, NZ.

Links between infrasound & health are not new

Having just read Mailbag for the May 2013 issue, I note the letters from Peter Carter and Ted Linney. As noted in the Editor's comment to Peter Carters letter, it is only recently and reluctantly recognised by authorities that wind farms do emit significant amounts of infrasound, although suspicions have been around for many years.

The best documented now histori-

cal example of ill effects on humans is with air-conditioning ducting outlets and this incident is also my own first knowledge of infrasound.

It goes back to 1964 in the UK during my technical traineeship in a large heavy electrical/defence company. A story came down the grapevine concerning an incident with a Russian-born French scientist, Vladimir Gavronsky, in 1962. This story in more detail is now on a number of internet sites including Wikipedia.

Gavonsky worked at a French facility associated with defence. The building had a room where the people who worked in it often experienced the now classic symptoms now associated with low-level infrasound exposure, but nowhere else in the same building.

Investigations were made by Gavronsky firstly on an unofficial basis, however after his discovery of low-level 7Hz sound emitted from the air-conditioning duct into that particular room, the investigation became official. The modulated air-flow was traced to the plant room and a faulty suspension on a fan motor platform. This allowed the platform to oscillate at 7Hz which modulated the air being forced into the duct. If the outside door to plant room was open, the effect went. Based on these findings a Hz generator was made and tested with unexpected dire consequences Gavronsky, along with an assistant, suffered severe neurological injuries and took months to recover.

This was probably the first case where the initial detection of low-level infrasound was recognised by illness in the human body. It applied to a number of people under the same, controlled conditions. How more scientific can you get? The case is well-documented and also had connections to the era of Cold-War paranoia, with some US and UK defence experimentation with infrasound as a weapon, something which Gavronsky also went on to explore. Some details of this defence activity are on associated websites.

Infrasound was also used by the Third Reich in their mass rallies prior

Volunteer readers needed for Vision Australia

Vision Australia (Blindness and Low Vision) has been providing an audio version of SILICON CHIP magazine to its borrowers for many years.

One or two committed volunteers come in each month to record large sections of your magazine onto CD but now we need more narrators.

Would any of your Melbourne-based readers be willing to come to our Kooyong studios for about six hours a month (weekdays only) to record SILICON CHIP for our blind and low-vision electronics enthusiasts?

If anyone is interested, I can be contacted on (03) 9864 9671 so we can arrange an audition and give them a chance to see if they would like to join our happy band of volunteers.

Barbara Taylor,
Vision Australia.

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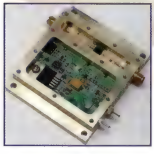

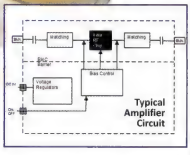

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Mailbag: continued

Wind farm induced sickness is all in the mind

I have recently read the Publisher's Letter in the March 2013 issue of SILICON CHIP and suspect that he is joking or is unaware of the significant amount of research available on the health effects of audible and infrasonic noise.

Below is a sample of citations, most of which are from reputable researchers and organisations, pointing out that the health effects are absent, other than being primarily subjective. These were largely gleaned from 20 minutes on the web.

The most recent article may be quickly reviewed at **www.straight.com/news/372551/david-suzuki-health-effects-wind-power-unfounded** which covers research in Australia and New Zealand, and gives concrete evidence for the no-harm conclusion.

The expert panel review at **www.awea.org/learnabout/publications/upload/awea_and_canwea_sound_white_paper.pdf** also concludes no health risk – see page 5-2. The appendices also provide a great deal of information about the Fundamentals of Sound, The Human Ear, Measuring Sound and the Propagation of Sound – a great addition to the information provided in the magazine.

My own experiences date back about six years when a large wind farm in Washington State carried out a trial of the ability of people in a nearby small town (about 10km away) to detect any effect. Some of these people had bitterly campaigned against the wind farm and complained of sleepness, headaches, etc. One night the wind farm had set up to stop all turbines and then survey the townspeople. As reported, not one of the people made a negative comment.

It was actually a sham trial and the turbines were not stopped. This is one small sample but in my years of wind farm involvement I have seen the body of research grow ever larger, with the evidence against negative health effects growing.

However, I laud the article about infrasound and the resulting instrument, and I will probably build it to understand and quantify why I have such a negative reaction to Harley motorcycles and deep bass woofers in cars.

Gavin Brickell,
Berwick, Vic.

www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_public_statement_wind_turbines_and_health.pdf

www.minutemanwind.com/pdf/Understanding%20Wind%20Turbine%20Acoustic%20Noise.pdf

www.maine.gov/doc/mfs/windpower/pubs/pdf/Addressing-WindTurbineNoise.pdf

www.wind-watch.org/documents/wind-turbines-and-low-frequency-noise-implications-for-human-health/

www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1265028759369

www.independentaustralia.net/2013/politics/the-truth-about-health-impacts-of-wind-farms-and-infrasound/

www.awea.org/learnabout/publications/upload/Utility-Scale-Wind-Sound-Fact-Sheet_WP11.pdf

www.windri.org/survey/references/windenergynoise.pdf

to the appearance of Hitler in order to make the crowd feel uncomfortable and then a few minutes before the appearance of Hitler the noise was switched off and the motivation of the now much-relieved crowd began. I think there is plenty of historical evidence alone to suspect a link between infrasound and detrimental effects to human health.

As indicated in Associate Professor David Bromwich's letter in the same pages, infrasound emissions from air-conditioning ducts are not unknown. Today, many people who work in large air-conditioned buildings complain of symptoms similar to those associated with low-level infrasound emissions. Perhaps now OH&S departments can afford to take an interest?

As I said in my previous letter, SILICON CHIP has released a very powerful tool.

Please note I am in no way against renewable energy systems; in fact, quite the opposite. However, I believe, like the Editor of SILICON CHIP, that the introduction of renewable energy has some unforeseen fundamental problems. These problems lie with the analysis which misses a piece of well-understood physics in the equation and that human abstract human invention "the monetary system". In simple terms, energy and the monetary system are now in conflict and energy will always be the dominant factor.

Kelvin Jones,
Kingston, Tas.

Industrial wind factory refugees

Thank you for your Publisher's Letter in the March 2013 issue, regarding health effects caused by these wind factories. It's a medical fact that if a person is sleep deprived, then their health suffers.

You can only know what someone experiences if you have walked in their shoes. Our home is unliveable (two doctors have told my wife to move away for her health).

Wind-factories don't result in one less scoop of coal being used to generate power. Wind-factory companies either cannot or refuse to prove otherwise. Wind-factories receive $500,000 per turbine, per year of taxpayers money. Wind factories at best operate at 17% of capacity and take power from the grid the rest of the time.

Don't take my word for it. Educate yourselves at:

www.stopthesethings.com/
www.waubrafoundation.com.au/

Name & address supplied but withheld at writer's request.

Comment: according to the Waubra Foundation's own field research, and from the clinical and acoustic research available internationally, the following serious medical conditions have been identified in people living, working, or visiting within 10km of operating

wind turbine developments. The onset of these conditions corresponds directly with the operation of wind turbines:

- *chronic severe sleep deprivation;*
- *acute hypertensive crises;*
- *new onset hypertension;*
- *heart attacks (including Tako Tsubo episodes);*
- *worsening control of pre-existing and previously stable medical problems such as angina, hypertension (high blood pressure), diabetes, migraines, tinnitus, depression, and post traumatic stress disorder;*
- *severe depression, with suicidal ideation;*
- *development of irreversible memory dysfunction, tinnitus, and hyperacusis.*

Frustrations with phone connection

With a technical background, it can be frustrating to be fed a load of mumbo-jumbo by call centre staff when calling about a technical problem. This saga evolved over two weeks.

I went to make a phone call one night and had no dial tone. I checked with a multimeter and actually had no DC on the line, either on-hook or off-hook. But my ADSL was working. To me that meant that the copper between my house and the exchange was probably OK or the ADSL would have been out too. My guess was a failure in the POTS (Plain Old Telephone System) or a disconnect between the POTS and the DSLAM (Digital Subscriber Line Access Multiplexer) in the exchange.

The next morning I rang Telstra, my phone supplier, and gave them the details. Of course, I had to go through the "have you removed all the products from the line" procedure. Yes, I'd done all that. I also explained that the ADSL was still up. They said they'd look into it.

Another day passed and I was at work when I got a call on my mobile from a non-English speaking Telstra technician to tell me that "is all fix now" and "was cross line – I call your number and get the other lady". I thanked him and, when I got home, the phone was now working but the ADSL wasn't. A "cross-line" definitely sounded like a problem in the exchange to me and they may have disconnected me from the DSLAM by mistake. I was starting to get "cross", even though I didn't have "the other lady" on my line anymore.

I called Telstra and quoted the job number. "Not our problem, the job is closed", they said as they'd fixed the phone fault. They insisted that if my ADSL was down I had to deal with my ISP. I explained that their "fix" had actually caused the ADSL to fail. That still didn't make it their problem, apparently. They claimed their technician didn't even go into the exchange to fix the fault. I asked to speak with a supervisor. "There's no supervisor here" was all the call centre person could say. I was promised, though, that the matter would be "put in his inbox and he'd call me". Of course, he didn't.

So, my only option was to call my ISP and explain everything yet again. They also said that they'd "look into it". They called me back the next day and said that the "AAPT technician says the codes are on the line". I asked what that actually meant and they admitted they

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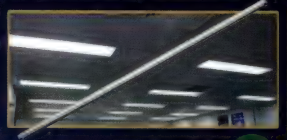

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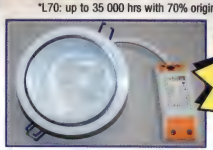

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Mailbag: continued

Simplified set-up for software defined radio

Thanks for the great article on the SDR in the May 2103 issue. I bought a DVB-T + DAB + FM dongle for the princely sum of $10.16 delivered and it works like a treat. I initially ran into a dead end, as I downloaded a version of SDR# that didn't know about RTL-SDR/USB. It was then I discovered a somewhat simpler way to set things up.

You go to **www.rtlsdr.org/softwarewindow** which shows how to install the driver using Zadig. Scroll down until you find *sdr-install.zip* which is a link. Download this file, unzip it and double click on the *install.bat* file in the newly created *sdr-install* directory to have the script download everything you need, including Zadig.

Run Zadig to install the driver and away you go. I am looking forward to the Up-Converter so I can tune across the HF bands.

Steve Quigg,
Mt Pritchard, NSW.

didn't know. I asked my ISP to get back to the AAPT technician with an email I had sent explaining the history and technical details of the problem.

The next day my ISP called me, repeated that "the codes are still on the line", and told me to either buy a new modem, have an AAPT technician come to the house for a minimum charge of $200 or to take it up with Telstra. I wasn't about to replace a perfectly good modem or pay $200 to have someone tell me that the problem was elsewhere and it very definitely wasn't my job to be the middleman between my ISP and Telstra.

By now I was beginning to get more than a little miffed. I strongly suggested that they, as my ISP, were being paid to provide a service which they weren't providing but for which they were still charging. I asked for the job to be escalated and fixed within a few days or I'd cancel my service.

Two days later my ISP called again and had me do crazy tests, including turning the modem off for at least two hours and then connecting it to the wall with less than 1m of phone cable as "cables longer than 2m from the wall will always cause ADSL to fail". I couldn't help but wonder how 1m of cable inside would make any difference to the 3km of 30-year old wet copper with lots of joins between the wall socket and the exchange. Still, I did all that they wanted and rang them back to swear that I'd done it.

I got a different person in the call centre this time. He pulled up my file and typed a few things. "Here we go again", I thought. He said, "this is all rather strange" and promised to look into it and call me back in under an hour. He actually did call back and it was less than an hour later! He'd called an AAPT technician directly.

This technician had said that the most likely cause was that the Telstra technician had simply fixed the crossed line by running my line directly to the POTS without going through the DSLAM. The AAPT technician himself would get Telstra to look into it as a matter of priority. This was 6pm on a Friday.

I got a call at 7am Sunday from a Telstra technician asking me to check if the ADSL was now working. It was. The caller ID showed he was somewhere local, so I asked if he was in the exchange. He was, so I asked if my line was even going through the DSLAM when he got there. No, it wasn't, and he'd just repatched it. Sure, the first Telstra technician never went near the exchange . . .

How would someone with no technical knowledge have handled this problem? Would they have bought a new modem or ended up as the middleman between their ISP and Telstra, quite probably paying one or both of them to come to the house when the problem wasn't even there?

They may well gone down any of these paths if they believed that "is all fix now" and that "the codes are on the line" meant the problem was in their house.

Kimble Dunster,
Chermside, Qld. SC

Get a LiFe with LiFePO$_4$ Cells

This heads-up on *safe* LiFePO$_4$ (Lithium Iron Phosphate) rechargeable cells outlines the possibilities and the drawbacks. Why be limited by Nicads or NiMH cells when you can get far more grunt from LiFePO$_4$ cells?

by Stan Swan

During early 2013 an alarming outbreak of fire occurred in the first batch of Boeing's 787 Dreamliner super jumbo planes. A second plane reported "smoke in cockpit". These were traced to the two 32V lithium battery packs, each containing eight 4V lithium-ion cells apiece. The suitcase-sized batteries are kept fully charged by the plane's main generators for standby use.

Fortunately no crashes or fatalities occurred but the adverse publicity and subsequent global grounding of the entire 787 fleet (rumoured to have cost Boeing US$50 million a week) has served as a great wake-up call on lithium cell types and associated issues.

By chance, IATA postal and air travel regulations have recently been upgraded too and some countries now prohibit air-mailing isolated lithium cells, no doubt for fear that they may short circuit en route.

So are today's lithium batteries simply too hot to handle?

Praised for their light weight and high energy and now abundant in numerous consumer devices (especially cameras, mobile phones and portable computers), some indeed may be potential fire hazards, even if treated with care and respect. There have been several "product recalls" for notebook computers, for example, where battery packs overheated to the point of distortion and in some cases, caused fires.

The situation may have parallels in the volatile aviation gasoline that WW2 era aircraft carriers stored for their high performance piston engined planes. In spite of robust precautions, battle damage could puncture even well-protected shipboard tanks or fuel lines and lead to explosive fumes wafting below decks. A stray spark could then ignite gas vapours and explosively destroy the entire vessel.

This tragically happened many times, notably with the USS Lexington during the 1942 Coral Sea battle and was a significant reason why carriers later became eager users of non-volatile kerosene-fueled jet aircraft.

So there is a corollary between the fuel problems of "real" aircraft carriers and model aircraft lithium-polymer (LiPO – as distinct from LiFePO$_4$) battery fires reported in Bob Young's Electric Model Planes article in the October 2012 issue of SILICON CHIP.

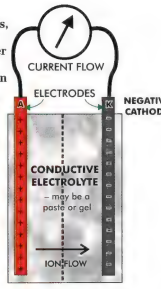
Basic electrochemistry

So-called "static" electricity has been known since ancient times but the fact that two different metals in a conductive liquid could also generate electricity was only stumbled upon two centuries ago. Huge efforts subsequently went into brewing up combinations of electrodes and electrolytes that generated higher voltages and currents, while being cost effective, long lived, light weight and with few side effects.

There are two types of electrochemical cells: primary (use once, discard when flat) and secondary (rechargeable) and they're usually known by the chemical symbols of their

Reproduced from our October 2012 issue, this photo shows the dangers of using Li-Po batteries (this one in a model plane transmitter). Less than a year later, LiFePO$_4$ batteries are a much safer proposition – but there are still some issues for the unwary!

While there are countless types of electro-chemical cells, operation is basically the same. A transfer of ions under chemical reaction causes a differential in voltage between the anode and the cathode. Conventional current can flow externally between them. In primary cells once the chemical reaction is completed the battery is exhausted. In secondary cells the chemicals can be rejuvenated by "charging", or applying an external current and the battery can be used over and over.



electrodes. Thus the common primary dry cell is C-Zn (carbon–zinc), a popular secondary cell is the Nickel-Cadmium (Nicad) or now more likely Nickel-Metal-Hydride (NiMH).

A myriad of primary and secondary types has evolved with the most common rechargeables being both "wet" lead acid (used in their millions in vehicles) and sealed lead acid (SLA "gel cel") which have been very popular in demanding consumer applications as well as for commercial and industrial uses.

None of these secondary cells (or batteries) have been without limitations, with low terminal voltage, short cycle life, poor standby and cold performance, weight and toxic internal materials being factors. As power hungry portable devices began their rise some 30 years ago, more suitable batteries were called for!

Incidentally, a battery (from an artillery term for a cluster of guns) strictly means a group of cells connected together, although modern usage is quite forgiving (slack?) with single cells often referred to as batteries.

Enter lithium

Those who paid attention during Periodic Table school chemistry lessons may recall lithium as the third element, after hydrogen and helium. So it's very lightweight, with appealing electrode potential and being a metal, it is conductive. In ionic form its tiny atoms can easily migrate across atomic obstructions and burrow into crystal lattices.

Given such features and its global abundance (being found in sea water and brine ponds), naturally lithium had long caught battery researchers attention! Although widely used in stable compounds in greases, glasses and alloys, isolated metallic lithium however can be dangerously reactive.

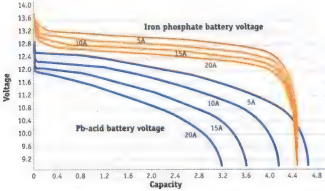
It's less so than other alkali metals (sodium and potassium) but when exposed to air it rapidly tarnishes and even reacts with the air's nitrogen and carbon dioxide. It's potentially explosive in contact with water and (as it floats in oils) lithium metal usually has to be stored under a cover of viscous petroleum jelly. Once ignited, lithium burns with great heat and becomes molten, with such fires often difficult to halt, requiring containing and smothering by dry powder fire extinguishers.

Lithium battery types

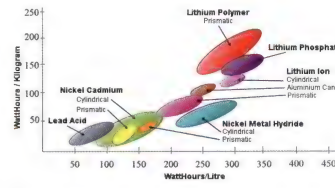
Dozens of lithium cell variations have arisen (refer to http://en.wikipedia.org/wiki/Lithium_battery) and are named after the cathode material (graphite anodes are traditional), along with a variety of conductive electrolytes. Although appealingly energy-dense, offering long life and light weight, many are primary types and may offer only "low" cell voltages (1.5V-3V). Coin-sized CR2032 and lithium AA types are typical.

In 1979 oxide chemist John Goodenough at Oxford University perfected a higher voltage (~3.6V) rechargeable lithium-ion type using Lithium Cobalt Oxide ($LiCoO_2$) and Lithium Manganese Dioxide ($LiMn_2O_4$), which Sony went on to commercialise in 1991. This "Li-Ion" (not *IRON*!) type is still the most common rechargeable lithium cell, although its slim Li-Po (lithium-ion polymer) offspring is increasingly ubiquitous in consumer products.

It's the laminated nature of today's sleek and powerful Li-Po batteries, along with their (often) negligible outer protective casing that is of increasing concern. Many YouTube video clips dramatically confirm the explosive nature of Li-ion/Li-Po cell contents when abused, exposed, shorted or overheated, or if charge/discharge circuitry is overwhelmed. (Again, we draw readers' attention to Bob Young's article mentioned above).



The discharge curves of similar capacity 12V lead-acid (6 cells) and Lithium-Iron-Phosphate (4 cells) batteries show the superior performance of the latter. LiFePO4 types are also only half the volume and a third the weight and have a much steadier output under varying loads.



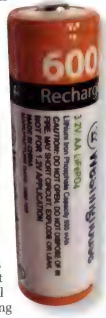
Here's a more graphic comparison of the various types of commonly-available secondary batteries. As you can see, the venerable Lead-Acid variety doesn't compare particularly well to even NiCad, while the Lithium varieties far outshine the rest.

Although awarded a lucrative prize, Goodenough didn't benefit financially from his Li-Ion discovery. But in 1996, while in his mid-seventies and back in his native USA, he patented a more stable and cheaper Lithium Iron Phosphate (abbreviated to $LiFePO_4$, LFE or even LiFe) cathode type.

It's this battery that this article is most focused on, and - given his surname - no doubt the gifted researcher (now in his 90s and still working as a professor at the University of Texas, Austin) endures ongoing puns that his first lithium rechargeable wasn't "good enough"!

The dates mentioned may be very relevant for the Dreamliner's woes, as the radical new aircraft's prolonged development meant Boeing's early 2000s choice of (Yuasa's) Lithium Cobalt Oxide batteries was seemingly made well before safer $LiFePO_4$ types became commercially available.

The rival Airbus A380 and A350 of the same era more cautiously settled on heavier (but safer) NiCad/NiMH types, as did early hybrid vehicles such as Toyota's Prius.



LiFePO4 features

LFP (we'll use the shorter abbreviation for convenience) cells are still quite new and their long-term features have yet to be fully verified. But their claimed characteristics include:

- An output of ~3.2V, which remains quite steady under load, only falling in the last 5% of capacity (Li-Ion starts near 4.2V but falls progressively to ~3V, while lead-acid is nominally 2V and NiCad/NiMH is only 1.2V)
- Lightweight and compact – extremely good power-to-weight ratio (appealing for motorcycles etc)
- Require constant current (CC) charging, which then tapers off as 3.6V constant voltage (CV) is reached. Note – LFP cell voltage settles back after full charging to ~3.3V.
- A specialised (but cheap) charger should be used, although simpler approaches may suffice in a pinch.
- No memory effect – cells can be charged/discharged at any state.
- Extremely low standby losses.
- Modest but appealing Ah (Amp Hour) capacity (but lower than comparable Li-Ions)
- A cycle life of several thousand times (and far greater than Li-Ion's annoying and costly hundreds of cycles)
- Can be near fully discharged (although 2.5V is the recommend cutoff) but will probably be ruined if totally discharged.
- High charge (~1C) and discharge (~10C) rates – both however are lower than comparable Li-Ions. ("C" refers to the capacity in Ah, with 700mAh being 1C for the AA cell type)
- Quite safe for all discharge applications, as the cathode is non flammable and stable.
- Excellent sub-zero and elevated temperature performance.
- Environmentally benign ("green") in manufacture, usage and disposal - no hazardous internal contents. No lithium remains in the cathode of a fully charged LFP cell.
- Capable of even further performance enhancement when doped with Yttrium – Y – (pronounced "it-tree-um" and a common element – found apparently in cabbages!). Such cells are titled $LiFeYPO_4$ (LFYP).

A 12V, 18.4Ah $LiFePO_4$ motorbike battery from Ever Power Energy Tech Corp, Taiwan.

Obtaining LFP cells

At the time of writing (April 2013) LFP cells and batteries are still elusive at most outlets. Specialists are beginning to stock them, especially as 12V LFYP batteries for performance motorcycles or demanding standby solar power applications.

Usefully, four cells (x 3.2V) gives 12.8V and smart LFP charging at 14.4V (4 x 3.6V) is comparable to traditional 12V lead-acid systems. This review now focuses on small and cheap individual "AA" sized cells that most users hopefully will soon encounter.

My selection of cells and dedicated LFP charger were obtained from a specialist NZ firm but prices were noted far cheaper via direct imports from Hong Kong/Chinese outlets, which focus on global battery sales. Although concerning for international air freighting, feedback from radio-controlled-plane enthusiasts indicates battery orders thankfully arrive in very rugged protective packaging.

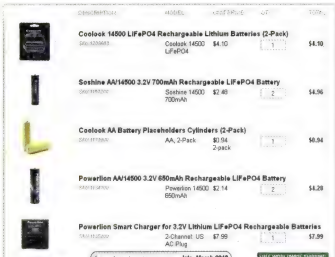
Note: Electrochemical cells, quaintly still known as A,B,C,D variants from the ancient valve electronics era, are increasingly being titled by their metric dimensions.

The common AA is 14500 sized since it's nominally 14mm wide x 50mm long. You'll occasionally see 14505 which are 14mm x 50.5mm – that extra 0.5mm can be crucial for making reliable battery contact. AAA sized cells, which are also available in $LiFePO_4$ chemistry, are known as 10440 (10mm x 44mm).

More powerful 18650 offerings (thus 18mm x 65mm and often used to stuff laptop battery packs and power tools) are of course much larger and hence will not fit common AA sized devices, battery holders or chargers. 18650 LFPs are currently being offered on ebay with up to 1800mAh capacity.

It's not difficult to obtain 700mAh AA cells for less than $3.00 each (including postage) out of China. AAA are even cheaper and larger cells (with higher capacities) are

LiFePO4 batteries are now being used in e-bikes due to their increased performance.



Ordering $LiFePO_4$ batteries over the 'net won't cost you sheep stations – here's my order for six cells, two dummy cells and a charger from www.fasttech.com (China) and it came to a grand total of $US22.27 – including postage! Prices on ebay are quite similar.

also common and relatively cheap. Of course, you're going to need a charger but these too are quite cheap (albeit of unknown electrical pedigree).

If you're looking for higher voltage/capacity LFPs, these are available but are still relatively expensive: a 12V 8Ah battery could set you back around $125, including postage. However, it weighs only 450g and measures just 60 x 60 x 100mm – compare that to a 7Ah SLA at 2.7kg and 65 x 92 x 150mm (admittedly, around $30 each).

First impressions

Four AA-sized LFP cells were obtained (Coolook, Powerlion, Soshine and a nameless blue) with all clearly labeled as being LiFePO4 3.2V rechargeable.

Beside modern NiMH, their capacities of ~700mAh didn't look high, but with a cell voltage almost three times greater they've comparable stored energy. Multiple series NiMH cells are needed for the supply to most items, whereas just a single LFP cell will suffice.

By the way, be very wary about ordering NiCd, NiMH or indeed any cells from overseas as many stories have emerged about their labelled ratings being somewhat exaggerated by unscrupulous dealers. Indeed, we've actually seen some "D"-sized NiCad cells labelled 4Ah which didn't seem to deliver the goods – and when opened up contained only a 600mAh "AA" cell cell fitted inside!

Supply over voltage alert

Numerous consumer items (torches, battery shavers, digital cameras) use two AA cells in series and thus run on nominally 3V. It's crucial to appreciate the higher (3.2V) $LiFePO_4$ cell voltage, as two LFP in series will supply 6.4V and may destroy the equipment if inserted! Only a single LFP will be needed, along with a conducting dummy link for circuit continuity. Although readily made (eg, with a nail inserted in a suitable piece of bamboo!), such dummy cells can be purchased cheaply.

Of course no doubt many dummies will be considered flat batteries, especially on April Fool's Day, and consigned to the bin before their true nature is apparent!

All cells received had terminal voltages near 3.2V but were given a top-up on a "Powerlion" $LiFePO_4$ AA charger. (This twin-bay smart charger handles both AA and AAA cells but in spite of the "Powerlion" title is only suitable for LFP types). It delivers about 300mA per cell, and indicates full charge by switching a red LED to green when 3.6V is reached (and held as CV).

Weight

Although much of an AA cell's weight is made up of the protective metal casing (which may be similar to the dummy's 8 grams), it was apparent that the LFP type has an attractive power-to-weight ratio. Being rechargeable and with claimed high cycle life, the total LFP ownership cost (even with a smart charger) may be attractively very low.

Tabled below are some typical AA cell weights and energy claims.

Initial consumer device trials

AA-powered digital cameras are valued by professionals for their "off the shelf" battery capabilities, which may arise in emergencies when well away from the mains charging that a Li-ion driven camera would require. Indeed, many cameras are supplied with an alternative "emergency" AA-battery holder for such eventualities.

Using AA alkalines or lithium primaries can become costly for power hungry devices of course, making rechargeable NiMH more attractive.

However, the low NiMH voltage often causes picky camera electronics to flag low batteries and (annoyingly!) cycle slowly, or even shut down totally.

Fitting a Canon A530 with a single LiFePO4 and a series dummy cell immediately made the camera sit up and eagerly start snapping! Spare LFP AAs could be carried and still give an overall weight saving compared to multiple alkaline cells. Revitalising such two-AA devices as a lethargic camera and LED torch was satisfying but a shaver with three flat AA cells also was found very responsive to a single LFP and two dummies (in place of its normal three series cells). Although the 3.2V supply was below the expected 4.5V (3 x 1.5V), the LFP's high current delivery pleasingly gave the stubble a real workout.

AA cell type and specifications	V x I x t Energy (approx)	Cell Weight (approx)	Energy/ Weight ratio	Lifetime cell cost (considering recharge cycles)
C-Zn (1.5V 0.7Ah)	1.5 Wh	17g	Modest	Medium
Alkaline (1.5V 2.0Ah)	3.0 Wh	24g	High	Higher
Lithium (1.5V 3.0Ah)	4.5 Wh	15g	Very high	Very high
NiCad (1.2V 0.6Ah)	0.75 Wh	18g	Low	Low
NiMH (1.2V 2.4Ah)	2.9 Wh	25g	High	Modest
$LiFePO_4$ (3.2V 0.7Ah)	2.2 Wh	17g	High	Very low
Dummy - - - - - -		8g	-	-

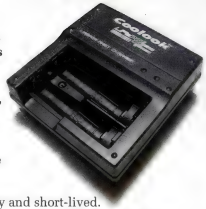
It should be appreciated that present AA-sized LFP cells have only modest energy storage ratings (typically 700mAh at 3.2V), meaning more frequent charging may be needed for power hungry devices.

However, with their claimed thousands of cycles the cells look easily up to this. And like early NiCad, NiMH and other secondary batteries, LFPs are expected to get higher capacities as manufacturing process – and demand – improve.

Conclusion

Lithium Iron Phosphate ($LiFePO_4$/LFP) rechargeable cells look to have a very bright future ahead. Their cheapness, light weight, high cell voltage, steady discharge level and abuse tolerance make them attractive in numerous applications where other primary and secondary cells are presently used.

On safety grounds alone, they may well become preferred to Li-ion/Li-Po types, especially where case damage or overheating may occur. Although not so much of an issue with cell phones and tablets (where rapid upgrading is the norm) $LiFePO_4$'s claimed thousands of charge/discharge cycle life may further appeal for demanding electric and hybrid vehicle use, as Li-ion battery packs for electric cars and bikes can be both costly and short-lived.



One of the perceived "disadvantages" of $LiFePO_4$ cells is that they cannot be charged with simple chargers such as used for NiCad or NiMH. Indeed, many "professional" chargers separately monitor each cell in a battery. For AA/AAA cells, though, purpose-made chargers (like this "Coolook") are cheap!

User awareness may be the key to $LiFePO_4$ AA cell uptake, as series dummy place holders must be specified with great certainty. With each LFP cell delivering 3.2V at high currents, yet in appearance similar (in AA form) to normal 1.2 -1.5V cells, particular care should be taken to avoid accidentally over-supplying devices!

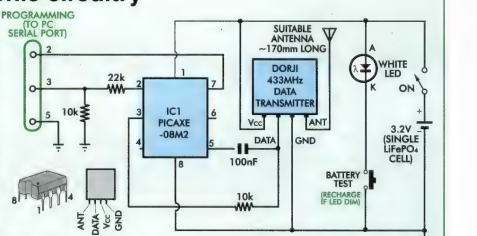
The likes of 6.4V (2 x 3.2V) in a digital camera designed for only 3V (2 x 1.5V) will almost certainly give it a "bad hair day".

Resources: For convenience these are hosted at: www.picaxe.orcon.net.nz/LFP.htm.

LFP powered electronic circuitry

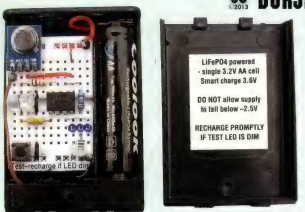
As a "proof of concept" trial a PICAXE/Dorji 433MHz beacon transmitter circuit was developed, powered by a single AA LFP and housed in a partially gutted 3 x AA switched battery box. Assorted low voltage cutoff sensors and PICAXE-driven software (especially the 08M2 "CALIBADC" command) were considered but initially just a dumb test LED was used for simplicity. In fact, it reminded me of the external "see the power" power-check strips featured on some Duracell alkaline AAs.

I had only 5mm white LEDs on hand (although naturally a smaller white could be used) but all showed significant dimming below 3V and most usefully for $LiFEPO_4$, a total light cutoff by 2.5V – a near perfect matching!



SC 2013

DORJI DATA TRANSMITTER USING $LiFePO_4$ CELL



The 433MHz "fox hunt" transmitter built on a protoboard and housed in a 3 x AA battery box – with one $LiFePO_4$ AA cell instead of three! We also included a white LED which serves as a battery level meter – press the switch and if the LED lights, the battery still has plenty of charge.

Such a simple battery state test could also be included with dumb circuitry (discretes, 555 etc) housed in a similar partially gutted $LiFePO_4$ powered box.

The breadboard section shown makes for great initial convenience but naturally Veroboard/Kiwi Board/PCB etc could be used for final soldered versions. A PCB "finger" or dummy cell would be needed for a single AA space in a 2-AA battery box.

The circuit simply sends an occasional Morse ID beacon tone transmission on the 433MHz ISM band and then sleeps at very low currents for an adjustable time (ie, a classic "fox hunt" transmitter). Battery life of the single LFP is estimated as being several weeks due to the low duty cycle. Further details and the controlling code (which features low battery alerts) are hosted at the article resource site (see above).

Quite aside from the $LiFePO_4$ insights the layout was motivated by the "potential" of the switched AA battery box, as discrete switches and suitable project cases can otherwise end up costing more than the internal electronics!

Do you hanker after a really large high-resolution monitor for your PC? Maybe a 30-inch job with a resolution of 2560 x 1600 pixels? Perhaps that's too expensive and you may have wondered about using a 32-inch LCD TV instead? We wondered that too – so we purchased a Dell U3011 30-inch monitor and an LG 32LS5700 32-inch Smart TV and did a comparison. Who won? Read on!

Most staff members in the SILICON CHIP offices use two monitors with their PC, typically a 24-inch 1.6:1 aspect ratio hi-res (1920 x 1200 pixels) combined with a smaller monitor.

For example, for the second monitor, I use an Acer 16:9 (1920 x 1080 pixel) in portrait mode. This mode is very good for reading emails, long documents or even scrolling through large directories.

Indeed, given the format of most websites, portrait mode is more usable than landscape mode and the monitor takes up less desk space.

Having two monitors means that you can have several files, directories and a whole bunch of stuff open and you can see it directly without having to use the Alt-tab key combination to switch between windows. It also means you can wipe over (select) a section of text and then drag it straight into a file you are working on.

Anyway, enough of the advantages of having two or more monitors. Once you have worked in that way you will find working with a single screen is liking trying to touch type with one hand tied behind your back.

But while 24-inch hi-res monitors are good, what about something bigger, say 30-inch? Six inches might not seem like a big increase but it gives a 56% increase in screen area, compared to a 24-inch (diagonal) monitor. And when you're looking at websites with a lot of picture detail, like SILICON CHIP

for example, that increase can make a big difference.

But mere screen size is not the whole story. Ideally, you should have more pixels if you are going to a larger screen size, because otherwise the pixels are larger, which is a problem with fine detail material. Coarse pixels means that the fine detail of pictures tends to break up.

That is why the 30-inch screen of choice, the Dell U3011, has a screen resolution of 2560 x 1600, compared to a standard PC monitor's resolution of 1920 x 1200 pixels. That's 77% more pixels and those pixels are smaller than the pixels on a 24-inch 1920 x 1200 monitor. More, smaller pixels means potentially much finer picture detail.

Nicholas Vinen uses two 24-inch monitors in the SILICON CHIP office but uses two 30-inch Dell monitors when working at home (the show-off!). He likes the larger screens when he is designing large, densely packed PCBs or when he is programming. The larger

The above photo shows an unretouched image, shot with a Nikon DSLR, of both screens operating side-by-side on my desk. They are displaying a typical double-page spread from the SILICON CHIP website. The LG 32LS5700 on the left; the larger (and significantly more expensive) Dell U3011 is on the right. Immediately obvious is the greater colour saturation on the Dell – but used individually, neither was a problem Also obvious (as you would expect) is the smaller image on the Dell.

On the LG, access to the broad range of inputs is very good, as shown above and in the enlargement at right. There are the usual AV & component video inputs, a LAN socket, audio input and an optical audio output.

At first glance the HDMI (4) and USB (3) sockets appear handily placed along the edge but its only when you plug in a cable – such as the HDMI shown above – that you realise they protrude past the side of the TV.

higher-resolution screen can display many more lines of code.

Problem is, not all computers can drive 2560 x 1600 pixel monitors. Late model desktops generally can but not via HDMI. Instead, you need a video card with a dual-link DVI output socket. This looks similar to a normal DVI socket but it has more active pins.

What about a 32-inch LCD TV?

Apart from needing a dual DVI signal, 30-inch 2560 x 1600 pixel monitors are expensive beasts, typically costing well over $1000.

Not only that, they tend to be power hungry. That got me thinking about a 32-inch LCD TV. At home I run an Acer Aspire 5560G 2.4GHz quad-core laptop PC driving a Benq 24-inch 1920 x 1080 pixel monitor.

The external monitor completely out-classes the laptop's 15.6-inch screen which only has a resolution of 1366 x 768 pixels and inferior brightness and contrast to boot.

Still, the combination gave me two screens and the advantages thereof. However, once we launched the new SILICON CHIP website with its 2-page-to-view presentation, it became apparent that a bigger screen than 24 inches was desirable for best viewing.

Partly, the reason for that is that I need glasses for reading and computer use and I like to take my glasses off when browsing the internet – that is the advantage of a big screen. A 32-inch screen would be so much better, I thought.

And so it was that after a good deal of internet research and price-checking, I ended up at the local branch of Harvey Norman to check out competing LG and Samsung 32-inch 1920 x 1080 pixel TVs.

I should say at this stage that not all current 32-inch LCD models are 1920 x 1080 pixels. The cheaper models still tend to be 1366 x 768 pixels; OK for casual TV viewing but certainly not as a computer monitor.

There was not much to differentiate between the competing LG and Samsung models so I asked the knowledgeable salesman which one he would choose.

He directed me to the top-of-the-line LG 32-inch set, the model 32LS5700, a so-called Smart TV. It had a lot of extra features, most of which did not have much immediate interest but it had a 100Hz refresh rate instead of 50Hz and a feature called "True-Motion" which gives smoother rendition of rapid motion when watching videos.

Apart from that it can be used to browse the internet in its own right, provided you can connect an Ethernet cable or have WiFi and a suitable dongle for the TV.

Anyway, the additional cost was relatively slight so the deal was done for less than $500. Compared to the price of a 30-inch Dell monitor, that's a bargain. Nicholas Vinen disagrees, as you will see elsewhere in this article.

When I hooked it up to my Acer laptop, I was delighted. The Acer immediately recognised the LG TV when connected via a HDMI cable and the impact of that big bright screen is sensational.

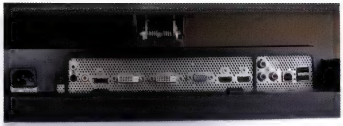
At a viewing distance of about 90cm, I can certainly discard the glasses and I am not in any way aware of the somewhat larger pixels (than on a 24-inch screen).

Another big advantage of using a TV set linked by HDMI is that you get sound as well. That means you don't need to rely on the laptop's internal speakers or separate powered speakers in the case of a desktop PC; less clutter on the desk is good.

Having said that, the sound quality of virtually all flat-panel TV is generally pretty mediocre and the LG Smart TV is no different in that regard. Mind you, 30-inch hi-res monitors don't come with in-built speakers so chalk that up as a big tick for the 32-inch TV set approach.

Furthermore, the LG Smart TV's LCD screen is an IPS panel (same as the expensive Dell 30-inch monitor). IPS stands for "in-plane switching" and was developed by Hitachi.

IPS panels have advantages over the



By contrast, the connectors to the Dell are not quite so accessible. They're all there, of course, but you really have to lay the monitor flat on its face to be able to plug in any leads – it's awful hard to do it when you cannot see the sockets! Fortunately, it's not something you have to do every day. Here the choices are DVI (2), VGA, HDMI (2), component video, plus USB, audio and Displayport sockets. There's also a power output for speakers.

earlier "twisted nematic" types in that they don't have marked colour shift when viewed off axis and their overall colour reproduction is better. Moreover, recent IPS panels have much faster response times; previously this was a disadvantage.

Over-scan

Still, there are traps and many 32-inch TVs will disappoint when you try to use them as a PC monitor. One little-known reason is over-scan. Most TV sets actually over-scan the broadcast signal by about 5%. What this means is that the edges of the "expected" picture are "lopped off".

This is a hangover from the days when all TV sets were CRTs (cathode ray tubes). Because the CRTs aged or the mains voltage varied, the TV set designers made sure that the broadcast picture always filled the screen by over-scanning.

Over-scanning means that a Windows screen is likely to have the task bars at top and bottom of the screen only partly visible. That means that you cannot minimise an application or close it down using your mouse.

To fix this problem you need to go into the TV's menu system to select "Aspect ratio" or something similar. What you are looking for is "Just Scan" mode which means that a 16 x 9 picture will exactly fill the screen.

Before purchasing a 32-inch flat-panel TV, you need to check that it has Just Scan mode or will not over-scan a 16 x 9 aspect picture.

Latency problems, too

When I started using the 32-inch TV as my main screen I noticed a strange problem. The mouse seemed to float all over the place as I moved it but its motion was still precise on the laptop screen.

When used with a desktop computer, the mouse worked fine when on the Benq 24-inch LCD monitor but became all floaty when I moved it over to the 32-inch screen.

As an aside, I still find it fascinating to have the mouse move from one screen to another, as if you have a super-wide screen split between two monitors (which is essentially what you get when using two monitors in "extended" as opposed to "duplicate" mode).

So what was going on? The problem became more noticeable when I happened to operate both monitors in "duplicate" mode (ie, same picture on both screens). When scrolling down the picture with the mouse the PC monitor would respond precisely to the mouse whereas the 32-inch TV would lag seriously behind.

Ah hah! I had a latency problem in the 32-inch TV.

Latency is really a problem for gamers because the screen may not respond quickly enough to the mouse or game console commands. The solution was to go into the set's Picture menu and switch it to Game mode. Again, some or many 32-inch sets may not have this facility so you need to check before you buy.

Energy consumption

While having two monitors on a desk is good from a productivity standpoint, it does mean more energy consumption, something I am very conscious of as electricity tariffs continue rising.

Benq 24-inch hi-res monitors pull about 35W so with two monitors, that means 70 watts on top of that pulled by the desktop machine itself. Still, we have recently upgraded some of the desktop machines and they are more efficient (and much faster) than the old machines so the overall electricity consumption in the SILICON CHIP offices has not changed by much.

So how power-hungry is the LG Smart TV? Answer: it is quite good.

In standby, it draws a piffling 180mW (milliwatts) or thereabouts. In normal use, it pulls less than 50W although you can reduce that by playing around with contrast and brightness settings.

If the laptop goes into sleep mode, the LG will display "no signal" on the screen and reduce the power draw to 30W. Ultimately it drops into standby (ie, 180mW) after a while.

To resume operation when the laptop wakes up you have to press the power button on the infrared remote or on the bottom righthand edge of the screen.

Just in case you think 50W is a bit high, the Dell 30-inch monitor pulls about 160W.

This is mainly due to the fact that it uses fluorescent back-lighting. The LG uses LED edge-lighting. This may not be quite as uniform as the Dell but it is perfectly acceptable.

Watching TV

So after tweaking some of the picture and sound settings, I was happy. At least I was until I tried watching TV while I worked on emails.

That was when it didn't work, due to severe interference from hash radiated by the HDMI cable. It turns out that this is a well-known problem. The

solution is to make sure you have a well-shielded and terminated antenna fly-lead and a shielded HDMI cable.

In my case though, the shielded cable was not the complete answer because there was still some interference on the channels that I most wanted to watch: SBS and ABC. That's Sod's Law at work!

I was able to get some improvement by snapping a couple of filter inductors over the HDMI cable but there are still times when I simply must disconnect the HDMI cable if I want to watc h TV while I work on the laptop.

Smart TV operation

Of course, if you have a "Smart TV" why not use it as a smart TV? That's what I thought too but so-called Smart TVs can be anything but "smart".

I have two smart TVs in my household and they are supposed to be good for video on demand, watching YouTube videos, Skype video and number of other services, besides being able to be used for general internet surfing.

However, you don't have to use the Smart TV for these functions for very long before you quickly come to the conclusion that a good laptop or desktop PC is far superior in virtually every aspect.

For example, when using Smart TV functions you quickly find that the standard TV remote control does not function well. You need a pointing device and if you are surfing the internet, browsing though YouTube videos or searching for shows on SBS or ABC iView, you need to be able to enter text.

With that in mind, I purchased the matching LG AN-MR300 remote control. This so-called "Magic Remote" is a UHF (2.4GHz) device with a matching USB dongle which plugs into the back of the TV.

The LG TV finds it as soon as it is powered up and you get large red pointer on the screen. The remote has a MEMS chips so as you wave it, the pointer moves from side to side. You can then hover the pointer over a section or block on the screen and click the scroll wheel to select it.

If you place the pointer in a section of the screen where text has to be entered, you just click the scroll wheel and it brings up a keyboard on the screen.

You can then enter text laboriously, by "hunting and pecking".

LG's futuristic AN-MR300 remote control. It's called a "magic" remote but we didn't find it too magical . . .

Life really is too short for this sort of nonsense. The scroll wheel is supposed to let you scroll down menus and screens but it only works some of the time. Considering that the LG's Magic Remote costs over $70, it is far from being a magic device.

I have also tried two 2.4GHz keyboards which are supposed to be ideal for use with Smart TVs. One had a trackball and scroll wheel while the other a touch pad for mouse operations. Both used used a tiny USB dongle which plugged into the rear of the LG TV set. But both were less than satisfactory.

Sure, the LG TV recognised them both and brought up the same large red pointer on the screen and you could move it around somewhat better than with the LG Magic Remote but neither would let me use their keyboard to enter text.

Why? Dunno. Maybe that will be fixed in the next series of Smart TVs from LG.

All of which would persuade me that the "Smart TV" in its present stage of development leaves a lot to be desired, especially when comparing the same functions via a PC.

The only apparent advantage of the Smart TV is that it gives a better quality picture when viewing programs on iView and SBS on Demand than it does when viewing the same programs via my laptop. Why? I have not been able to work that out.

Given that I am quite happy with using this TV set as a large monitor, I asked Nicholas why he decided to spend so much more on a display which is actually smaller.

His response was to quote Top Gear presenter James May (never a good sign): "As you would expect, I have done this properly." At the risk of getting a detailed and tedious response (a la James May), I shall let him take over and explain. He even sounds like James May.... (In fact, he is even hirsute like J. M.)

Nicholas responds:

The difference between the two monitors is really like night and day. To start with, the Dell U3011 has twice as many pixels as a 1080p display; 2560 x 1600 = 4 million compared to 2 million.

So if you have reasonably good vision and sit within about half a metre of the screen then you will get crisper text, better-defined graphics and overall, can fit more content on the screen before it becomes unusable.

As mentioned earlier, this is especially apparent when doing a task such as PCB layout where you can zoom out and get a wider view of the PCB while still being able to differentiate the tracks, read component labels and so on. But it's also useful when working in a text editor, viewing or editing photos or any number of other tasks.

Also, the pixels on Leo's TV are so big that with my (relatively) young eyes, when sitting close to it I can see the individual red, green and blue subpixels. That's very distracting, especially when dealing with high-contrast situations like word processing (black on white text).

The U3011's viewing angle is excellent at 178°, both horizontally and vertically, thanks to its in-plane switching (IPS) panel. While some dimming is apparent if you are viewing it from an extreme angle, there is no colour shifting.

That can be a real problem with cheaper panels (even some IPS types) and having a good viewing angle is critical with such a large monitor because if you are relatively close to it, no matter where you park your head, you will be looking at some of the screen at an angle.

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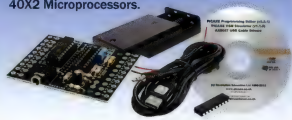

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Also, as mentioned earlier, being back-lit rather than edge-lit, the Dell monitor has good brightness uniformity despite its large size.

Colour accuracy

There's also the issue of colour gamut (ie, range of colours which can be displayed) and colour display accuracy.

Unlike many cheap LED-backlit LCD monitors, this one has very good colour reproduction although it does have a significant warm-up time (a few minutes) to get to full brightness and during this time, colour display will be less accurate.

In theory, CCFL backlights don't have as long a life span as LEDs but I have an older 76cm Dell (3007WFP) which has been in constant use for over five years (at around half brightness) and does not show any obvious signs of backlight dimming or significant colour shift.

Anyway, getting back to why my monitor is so much better than Leo's... its gamut is 99% of the Adobe RGB colour space and 100% of the sRGB colour space.

While it isn't calibrated for top-notch colour accuracy (like, say, a very expensive Eizo monitor), it does have fairly strict specifications for initial colour accuracy and comes with a graph showing both greyscale and spot colour accuracy from the factory.

So for jobs like photo editing (or even just viewing) it's pretty good and certainly way better than your typical TV or monitor.

Also, I much prefer its 16:10 aspect ratio to the 16:9 aspect of widescreen TVs.

Sure, they are great for watching TV shows and movies shot in 16:9 or 2.35:1 but when it comes to doing work on it, I find the taller aspect more appealing (it's close to the golden ratio!) and also more practical, as things like text documents in portrait mode fit better. It's also closer to the 3:2 aspect of photos from an SLR camera.

Consider that a few years ago, a typical 56cm (22") monitor had a resolution of 1920 x 1200 pixels and now most in this size are 1920 x 1080; while the prices have come down, you get 10% fewer vertical pixels to work with.

In fact if I were to buy a 56cm (or similar size) monitor I would probably get a 16:10 model, even if it cost more.

But you want the larger 76cm (30") set if you can afford it – 56cm just looks so puny by comparison.

My monitor also has an anti-glare coating which can be very helpful if you are going to be working with bright lights behind you, such as with an open window during the day.

Shiny screens may look nice in the store and are admittedly a bit easier to clean but the reflections can really be a problem under some lighting conditions and will interfere with your viewing of what's displayed on the screen.

As Leo said, the Dell does consume more power than his TV (which has LED backlighting) but indoors, you probably won't want to run it at full brightness – I certainly don't.

With a large monitor, when the screen is mostly white (eg, in a word processor), it feels a bit like you're being interrogated (you know, like in the movies, with a light shining in your face).

With the sort of brightness levels I actually use, its power consumption drops below 100W. If you consider that it has roughly twice the screen area and pixels as a 56cm (22") monitor then by comparison, that isn't bad at all.

No lag

Then we get to the delay.. or lack of it. Since it's designed as a monitor, the Dell updates at 60Hz and there's no internal processing so the delay from the computer updating its memory frame buffer to the pixels changing on the screen is only about 20ms, which is unnoticeable.

The response time of the pixels themselves is 7-17ms which is pretty good and these days, virtually all LCD monitors have a fast enough response time for any application. Certainly there is no sign of motion blur with movies or games on this monitor.

Even in games mode, Leo's TV still has some lag although it's much better than it was when he first hooked it up – it was so bad then that you'd move the mouse and then wait for the cursor on the screen to catch up with you!

While it isn't a TV, the U3011 does have a pretty good set of inputs including two digital video interfaces (dual link DVI – required to get the full resolution), two HDMI inputs, DisplayPort, VGA and component video.

In fact if you had a set-top box and external audio amplifier you probably could watch TV on it. HD videos look great, played back through the connected computer.

Oh, and by the way, the U3011 has a built-in 4-port USB 2.0 hi-speed hub and compact flash/SD card reader. That's a pretty common feature on monitors these days but TVs, not so much.

Drawbacks

There are a few things I don't particularly like about the U3011 though. After you press the power button, it takes several seconds before the backlight turns on.

There is a similar delay when performing other tasks such as switching inputs.

Oh, and when you press the buttons, the monitor tends to flex and rotate on its stand which can be annoying.

Also, you can't get native resolution via HDMI, even if your laptop (or other signal source) supports HDMI 1.4. This is partially fixed with the new version of the monitor which is now on sale (see below).

The best way to drive these monitors is still either Dual-link DVI or DisplayPort; Dual-link DVI is common on newer desktop computers and DisplayPort (or its mini version) is normally present on Apple laptops but with other brand laptops you may have trouble driving the monitor at its full resolution.

We should also mention that while we find the high-end Dell monitors to be fairly reliable, if you do need to get it serviced you will have to go back to Dell for service, as access to service manuals and spares is poor.

But you get a 3-year warranty with these monitors and they also have a zero dead pixel guarantee.

So at least you're covered for the first three years.

New model

Since we bought the U3011, that model has been discontinued and replaced with the U3013. As expected, they have moved to LED backlighting which reduces power consumption (down to 120W max, 60W typical) but have managed to maintain the excellent colour gamut. Presumably this is through the use of high-quality, wide-gamut LEDs.

They have also taken the time to update the electronics, adding USB 3.0 support, changing one of the HDMI inputs to Mini DisplayPort and upgrading the remaining HDMI support to version 1.4, so that it can handle the full resolution and not just 1920 x 1200.

But we have heard that some users are reporting that they can't get the full 60Hz refresh rate at 2560 x 1600 over HDMI and are stuck with about half that (even though HDMI 1.4 should support this resolution at up to 75Hz), so it seems like the HDMI input issue has not been fully solved.

By the way, laptops with the Intel Ivy Bridge or Sandy Bridge chipsets generally have HDMI 1.4 outputs so are capable of driving monitors up to resolutions of at least 2560 x 1600 pixels.

We expect the panel in the U3013 is similar to or even identical to the one used in the U3011.

By the way, you can also get 76cm monitors from other manufacturers, such as Apple; some may be cheaper than the Dell and others more dear. The backlight, input selection and other electronics will vary between the different manufacturers.

Why did we buy a Dell? Mainly because we got it for a good price...

What's the damage?

List price for the U3013 is AUD $1800 but Dell periodically have sales on monitors. We got our new U3011 for under $1200, direct from Dell.

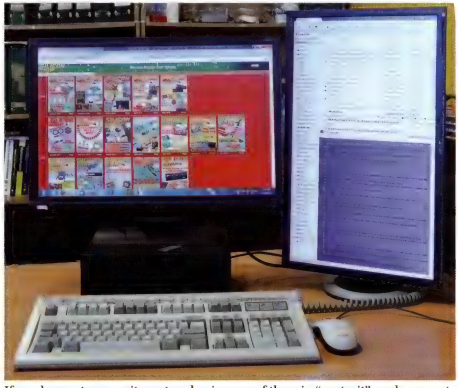
This was just before the U3013 was introduced and was probably intended to get rid of old stock but we expect that the U3013 will eventually go on sale too.

Even at full price though, if you use your computer a lot, especially for graphically intensive tasks, we feel that it's money well spent.

If you can't stomach that price, a number of manufacturers (including Dell) offer 68cm (27") monitors in a 16:9 aspect with a resolution of 2560 x 1440 pixels.

I still prefer the 16:10 aspect and like the extra pixels but the difference in cost can be huge – the 27" monitor may be half the price of the 30".

And while the same provisos apply regarding the difficulty in driving a high-resolution monitor with some PCs, I would definitely go for one of these if I couldn't afford the larger unit. SC



If you have a two-monitor setup, having one of them in "portrait" mode can not only save you desk space, it will give you a more readable display for things like correspondence, file listings, even some web pages and much more. The biggest problem is that not too many monitors these days have the hardware to mount in portrait mode, even though it's easy to set up via the Windows (XP, 7 etc) "screen resolution" tab (right click on a blank screen).

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An LF-HF Up-Converter for VHF/UHF SDRs

By JIM ROWE

As we saw last month, DVB-T dongles can be used to turn almost any PC into an easy-to-use software defined radio or "SDR" for VHF and UHF frequencies above about 52MHz. But since the dongles don't work below 52MHz, you can't monitor all the interesting stuff below this frequency, such as the amateur bands and shortwave radio, CB radio and airport beacons and so on. This LF-HF Up-Converter solves that problem.

WE ASSUME THAT last month's article on a software-defined radio (SDR) using a cheap digital TV dongle has you champing at the bit. For less than $30 you can have an SDR with most of the features of a fancy and expensive communications receiver with all sorts of reception modes.

Now we are describing an Up-Converter so you can monitor signals in the frequency bands below 52MHz. What's an Up-Converter? It takes LF (low-frequency), MF (medium-frequency) and HF (high-frequency) radio signals and shifts them up into the VHF (very high frequency) region where they can be received by a VHF radio receiver, specifically an SDR using a PC with a DVB-T dongle, as described last month.

By the way, the terms LF (30-300kHz), MF (300kHz-3MHz) and HF (3-30MHz) are all used to describe radio signals at frequencies below 30MHz, while VHF is used for signals from 30-300MHz, and UHF for signals above 300MHz.

The Up-Converter described here uses the heterodyne principle to shift the LF-HF signals up by 125MHz, so that for example, a 500kHz signal moves up to 125.5MHz and a 1.25MHz signal moves up to 126.25MHz, and so on. Similarly, an HF signal of 29.75MHz moves up to 154.75MHz (ie, 29.75 + 125). As a result, any sig-

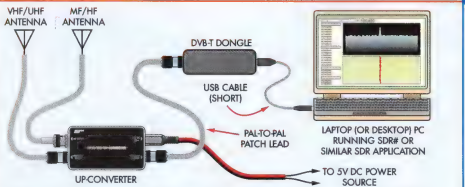


Fig.1: the Up-Converter is inserted between the two antennas and the DVB-T dongle. It up-converts the signal from the MF/HF antenna only when it is powered up. When it is not powered, an internal relay switches the VHF/UHF antenna straight through to the dongle, thereby bypassing the Up-Converter.

nals down in the LF-HF region of the spectrum get moved up into the VHF region starting at 125MHz which can be tuned by the SDR.

The Up-Converter is a little metal box with two antenna connectors, one for VHF & UHF signals and one for signals below 52MHz. It has a single output which connects to the antenna input on the USB DVB-T dongle which plugs into a USB port on your laptop or desktop PC. The general arrangement is depicted in Fig.1.

The Up-Converter contains a relay which switches between the up-converted output and the VHF/UHF signal (ie, the "straight-through" or bypass condition). When the Up-Converter is powered up, it automatically feeds its up-converted signal through to the DVB-T dongle. When it is not powered, it is bypassed and the signals from the VHF/UHF antenna are fed directly to the dongle. This avoids any need for swapping over antenna cables.

SDR shift

You might think that this "shifting up by 125MHz" would cause confusion when you're using the Up-Converter with your SDR but if you're using an SDR software application like SDR# this isn't so. That's because SDR# has a feature which automatically compensates for frequency shift.

This feature is enabled by clicking on the box next to the label "Shift", in the Radio panel at upper left. All you have to do is type the conversion frequency into the text box to the right of the "Shift" label but note that it must be entered as a negative number, so that it will be subtracted from the up-converted frequency in order to display the correct signal frequency.

When you have the Up-Converter turned on, all you have to do is click on SDR#'s "Shift" box to have it display the correct LF-HF input signal frequency. If you want to swing back to receiving in the VHF-UHF bands, turn off the power to the Up-Converter and click on the "Shift" box to disable it.

Circuit details

The full circuit diagram of the Up-Converter is shown in Fig.2. Only two chips are involved: a mixer (IC1) and

Main Features & Specifications

- Up-converts (shifts) LF-HF radio signals up by 125MHz into the VHF spectrum, for reception via a PC-based SDR using virtually any DVB-T dongle.
- Incorporates a signal-switching relay so that when power is not applied to the converter, the VHF signal output is switched directly to the VHF/UHF input from an antenna to avoid the need for cable swapping.

LF-HF input impedance: 50Ω unbalanced, with overload protection diodes.

VHF/UHF input/output impedance: 75Ω unbalanced.

Conversion gain: approximately +10dB ±2dB over the input range 100kHz-55MHz (corresponding output range 125.1–180MHz).

Power supply: external 5V DC source (see text); current drain less than 70mA.

Parts List

1 diecast aluminium box, 110 x 60 x 30mm
1 PCB, code 07106131, 80 x 51mm
1 front-panel label (see text)
1 HCMOS 3.3V crystal oscillator module, 125MHz (Fox Electronics FXO-HC536R-125 or similar) (element14 2058072)
1 390nH SMD inductor (0805)
1 SPDT 5V mini DIP relay, JRC-23F-05 or similar (Futurlec)
1 ferrite toroid, 18mm OD x 6mm deep (Jaycar LO-1230)
1 ferrite balun core, 14mm long (Jaycar LF-1220)
1 500mm length of 0.25mm enamelled copper wire
1 150mm length of 0.8mm enamelled copper wire
1 100mm length of 1mm-dia. tinned copper wire
3 small Nylon cable ties
1 BNC socket, single hole panel mounting (CON1)
2 75Ω PAL sockets, single hole mounting (CON2, CON3)
1 2.5mm concentric power socket, PCB-mount (CON4)
4 M3 x 10mm untapped spacers
4 M3 x 20mm machine screws
4 M3 hex nuts
4 self-adhesive rubber feet
1 5V DC plugpack or USB/DC adaptor cable

Semiconductors

1 SA602AD/01 or SA612AD/01 double balanced mixer (IC1) (element14 2212077 or 2212081 respectively)
1 LP2950-3.3 or LM2936-3.3 LDO regulator (REG1)
2 1N5711 Schottky diodes (D1-D2)
1 1N5819 1A Schottky diode (D3)
1 1N4004 1A diode (D4)

Capacitors

2 47µF 16V RB electrolytic
1 220nF multilayer monolithic ceramic
2 10nF multilayer monolithic ceramic
1 10nF COG-NP0 SMD ceramic (1206)
1 470pF disc ceramic
1 3.3pF COG-NP0 SMD ceramic (1206)

Resistors (0.25W)

2 10kΩ SMD (0805)

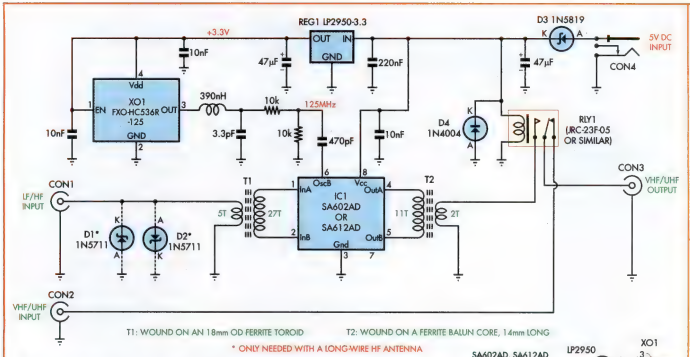


Fig.2: the circuit is based on two ICs: an SA602AD/01 double-balanced mixer (IC1) and a 125MHz crystal oscillator (XO1). The balanced input signals at pins 1 & 2 of IC1 (fed in via transformer T1) are mixed with the 125MHz signal to produce sum and difference signals and these are fed via matching transformer T2 to the output via relay RLY1.

a 125MHz crystal oscillator (XO1).

IC1 is an SA602AD/01 (or SA612-AD/01) double-balanced mixer designed specifically for this kind of use. The LF-HF signals to be up-converted enter the circuit via CON1 and are fed through matching transformer T1 before being fed into the balanced inputs at pins 1 & 2 of IC1.

The crystal oscillator module, XO1, is a very small HCMOS SMD device which produces a 125MHz clock signal at its pin 3. Its output voltage is 2.65V peak-peak, which is rather too high for linear operation of the mixer. In addition, it's essentially a square wave, rich in harmonics of 125MHz as well as the fundamental.

So we feed it through a low-pass filter formed by the 390nH inductor and 3.3pF capacitor first of all, to filter out most of the harmonics (which would contribute to spurious signals themselves, via cross-modulation in the mixer). Then we reduce the filtered 125MHz signal down to a more suitable level for the mixer, via a voltage divider using two 10kΩ resistors. The signal is then fed into the oscillator input (pin 6) of IC1 via a 470pF coupling capacitor.

Inside the mixer, the balanced input signals at pins 1 & 2 are mixed with the 125MHz signal and the mixing products appear in balanced form at the outputs (pins 4 & 5). Because IC1 is a double-balanced mixer based on a Gilbert cell, the outputs contain very little of the original input signal frequencies (F_{in}) and very little of the oscillator frequency (F_{osc}, 125MHz). Instead, they mainly they contain the "sum" and "difference" products, as follows:

Sum product = ($F_{osc} + F_{in}$)
Difference product = ($F_{osc} - F_{in}$)

It's the sum product that we're really interested in, of course. Although the difference product is also present in the outputs, it is in a different tuning range and so it can be ignored.

The balanced output signals from the mixer feed matching transformer, T2. As well as stepping them down in

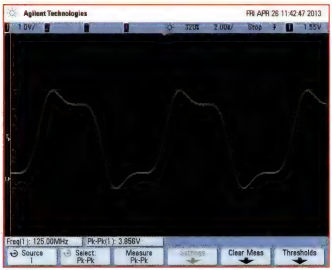


Fig.3: this scope grab shows the 125MHz signal from the crystal oscillator. This was measured using a 400MHz probe and a 350MHz scope, so many of the upper harmonics have been heavily attenuated. Even so, it can be seen that the waveform is far from sinusoidal and that's why it's followed by an LC filter to clean it up and so reduce spurious responses.

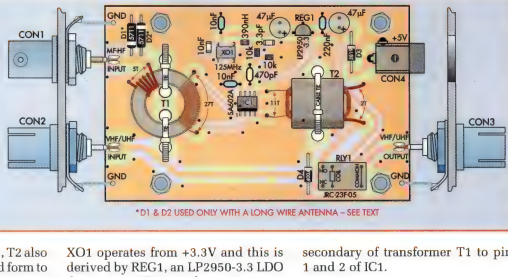


Fig.4: install the parts on the PCB as shown on this layout diagram staring with the SMD components. Make sure that IC1 and XO1 (the crystal oscillator) are correctly orientated and note that you can remove any inadvertent solder bridges between IC1's pins using solderwick. Diodes D1 & D2 are needed only if you intend using a long-wire HF antenna.

impedance level (1500Ω/75Ω), T2 also converts them into unbalanced form to provide better matching to the input of the DVB-T dongle (or to any other VHF receiver, for that matter).

The secondary winding of transformer T2 connects to the normally open (NO) contact of relay RLY1. This means that the converter's output is only connected to CON3 when the converter is powered up. When +5V power is not applied, the moving contact of RLY1 connects to the normally closed (NC) contact and this connects directly to the converter's VHF/UHF input connector (CON2).

Most of the remaining circuitry in Fig.1 is to supply IC1, XO1 and RLY1 with power. IC1 and RLY1 operate from the nominal +5V rail, with diode D3 used to provide reverse polarity protection and D4 to absorb any back-EMF spikes which may be generated by the coil of RLY1 when power is removed. Crystal oscillator module XO1 operates from +3.3V and this is derived by REG1, an LP2950-3.3 LDO device in a TO-92 package.

The current drain of the Up-Converter is about 68mA, so it can be powered from a spare USB port on your PC, if you wish.

In some cases though, the USB port on your PC may not be up to the job. That's because because the bypass capacitor on the supply input of the Up-Converter is 47µF and the charging inrush current will exceed the maximum quoted in the USB specifications. Give it a go – if it doesn't work, you will have to use a 5V DC plugpack.

Diodes D1 & D2 protect IC1 from damage due to EMI spikes which may be induced into an external long-wire LF-HF antenna (if that is what's being used). As shown, these two diodes are connected in reverse parallel and they limit the input voltage to around 500mV peak-peak, corresponding to around 2.7V peak-peak from the secondary of transformer T1 to pins 1 and 2 of IC1.

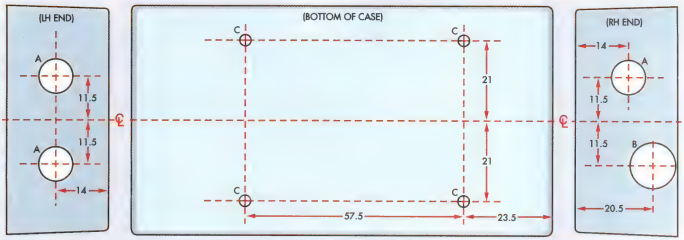
Construction

Apart from the three RF connectors CON1-CON3, all of the components are fitted on a PCB measuring 80 x 51mm and coded 07106131. The PCB and the three RF connectors are housed in a small diecast aluminium box, measuring 110 x 60 x 30mm. The component overlay is shown in Fig.4.

There are seven SMD components in all, comprising IC1, XO1, the 390nH inductor, the 3.3pF capacitor, one 10nF capacitor (alongside XO1) and the two 10kΩ resistors. We suggest you solder them to the PCB before fitting anything else. This will make it easier, especially if you fit the five passive components first and then the two slightly larger active parts.

Both the SA602AD/01 and the SA-612AD/01 mixer devices are in SOIC-8 packages and are pin compatible, so

The completed PCB is installed in a metal diecast case, with the antenna input & output sockets mounted at either end. An on-board DC socket is shown here but an option is to use a panel-mount DC socket instead and include a power on-off switch between it & the PCB, so that the unit can be easily bypassed if you want to feed VHF/UHF signal straight through.



HOLES A ARE 9.0mm IN DIAMETER, HOLE B IS 12.0mm IN DIAMETER, HOLES C ARE 3.0mm IN DIAMETER (ALL DIMENSIONS IN MILLIMETRES)

Fig.5: this diagram shows the drilling details for the metal case. The holes in the case ends should be made using a small pilot drill initially and then carefully enlarged to size using a tapered reamer.

Performance Limitations

While the combination of this Up-Converter and a DVB-T dongle can provide most of the operating features of a high-performance communications receiver, it's unrealistic to expect the same performance. The high cost of communications receivers is the price you pay for superb sensitivity & selectivity, FM quieting, excellent image performance and so on. You are not going to get that sort of performance from a set-up costing a good deal less than $100.

Apart from anything else, most DVB-T dongles are in a plastic case and that provides no shielding against the ingress of strong VHF signals like those from FM stations and DAB+ stations. So even though we have tried to make the Up-Converter's output as clean as possible, you're still likely to find spurious breakthrough signals in the part of the VHF spectrum into which the Up-Converter shifts the incoming HF signals.

Another reason why spurious signals can appear is that the input circuitry of the Up-Converter is broadband rather than tuned; that keeps it simple and low in cost. In other words, the Up-Converter simply moves all signals in the 100kHz - 60MHz part of the spectrum up into the VHF spectrum, without favouring or discarding any particular signal frequency.

By contrast, a true communications receiver has complex front-end tuning or pre-selection to keep strong unwanted signals at bay.

In spite of that, it's surprising what results you can get out of the DVB-T dongle/Up-Converter combination, particularly if you team them up with a long-wire HF antenna or an active indoor HF loop antenna with its own low-Q tuning circuit.

you can use either as IC1. Both are made by NXP (formerly Philips) and are available from a number of suppliers including element14.

Whichever one you use, just make sure you fit it with the orientation shown in Fig.4, ie, bevelled long edge downwards.

XO1 is a tiny surface-mount module with a footprint of only 4 x 3mm. The modules used in the prototypes were Fox XPRESSO FXO-HC536-125 types (also available from element14). Its orientation is again critical, so make sure you position it with connection 1 (indicated by a tiny arrow or "fox-head" symbol etched into one corner of the top sealing plate) at lower left as viewed in Fig.4. You may need a good magnifying glass to locate the fox head symbol.

After fitting the SMD devices, you can then mount DC input connector CON4, the leaded capacitors and relay RLY1. The relay is also very small, measuring only 12 x 7 x 10mm (L x W x H). We used a JRC-23F-05 relay from Futurlec in the prototype.

Next you can add regulator REG1 and diodes D1-D4, making sure that you fit the correct diode in each position and with the orientation shown in Fig.3.

Note, however, that diodes D1 & D2 need not be fitted if you use an inside loop antenna rather than an external long-wire antenna. In fact, with an inside loop antenna, it's best to leave them out. Also, if they clip strong signals from an external antenna, they can produce distortion which may cause spurious signals to be generated, so again they may have to be omitted.

Winding the transformers

Transformers T1 and T2 have to be hand-wound, on an 18mm OD x 6mm-deep ferrite toroid in the case of T1 and a 14mm-long ferrite balun core in the case of T2.

The primary winding of T1 consists of five turns of 0.8mm ECW (enamelled copper wire) wound fairly closely on one side of the toroid. The secondary winding has 27 turns of 0.25mm ECW, again wound fairly closely on the opposite side of the toroid. When both windings have been made, cut the free wire ends to about 10mm long and then strip off about 6mm of enamel from the end of each wire.

That done, lower the toroid assembly onto the PCB, with each of the four wires passing down through their matching holes. Before you

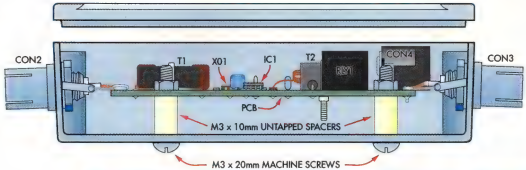


Fig.6: the PCB is mounted inside the case on M3 x 10mm untapped spacers and secured using M3 x 20mm machine screws & nuts. It's a good idea to fit four rubber feet to the underside of the case, so that the screw heads cannot scratch the resting surface.

solder them to the pads underneath, secure the toroid to the PCB using a pair of small Nylon cable ties – passing around the toroid and up and down via the 3mm holes provided.

These cable ties will hold the toroid and its windings firmly in place while you solder the winding wires.

Transformer T2 is wound in much the same way, except that in this case the winding wires are passed up one hole in the balun core and then back down the other hole, and so on. The secondary has only two turns, wound with 0.8mm ECW, so it's best to wind it first. Then you can wind the primary, which has 11 turns of 0.25mm ECW. When you have completed both windings, cut the free wire ends to about 10mm long and then strip off about 5mm of the enamel from each end.

You should then be able to lower the complete assembly down onto the top of the PCB, with the wire ends passing down through the matching holes. The balun core should then be held down against the PCB using a single Nylon cable tie, passing through the two 3mm holes provided.

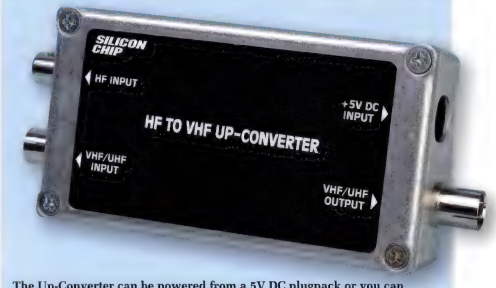
Finally, solder all four wire ends to the pads underneath to complete the Up-Converter's PCB assembly. Now you can prepare the box.

Drilling the box

The position and size of all eight holes to be drilled are shown in Fig.5. The four 3mm-diameter holes in the bottom of the case are for the PCB mounting screws, while the two larger holes at each end are for mounting the three coaxial connectors CON1-CON3 and also for providing access to the DC power input connector CON4.

Mark the location of all eight holes first, then centre-pop them to prevent the drill from wandering. Then drill them all with a 3mm drill. The three holes marked "A" and the larger hole marked "B" can then all be enlarged and carefully reamed to the specified diameters using a tapered reamer.

That done, you should lightly countersink the 3mm holes on both sides to remove any burrs, and use a small half-round file to remove any burrs from the larger holes at each end.



The Up-Converter can be powered from a 5V DC plugpack or you can purchase (or make up) an adaptor cable to run it from a USB port (see text).

Mounting the PCB

You will need to mount the PCB in the box before fitting the three coax connectors.

As shown in Fig.6, the PCB assembly mounts inside the box on four M3 x 10mm untapped spacers and is secured using four M3 x 20mm machine screws and nuts. Once this has been done, it's fairly straightforward to mount the three coaxial connectors in the ends of the box.

In each case, you simply feed the connector's body in through its matching hole, fit the spring washer/earthing lug and then screw on the mounting nut. Tighten up the nuts using a 12.5mm spanner to secure the connectors firmly in place – ideally with the earthing lug roughly level with the centre spigot and on the outer side of it so that can be linked to the earthing pad on the PCB nearby using a short length of copper braid or 1mm tinned copper wire – see Fig.4.

Make sure you use the BNC connector for CON1, and the two Belling-Lee/PAL connectors for CON2 & CON3.

With all three connectors now mounted on the box ends, solder the centre spigot of each one to its matching solder pad on the end of the board and connect the earthing lugs. Finally, attach the box lid using the four M4 screws provided and your Up-Converter is complete.

Trying it out

There are no setting-up adjustments to be made, so trying it out is just a matter of linking the converter's output connector CON3 to the input of your SDR dongle using a PAL-to-PAL patch lead of suitable length and then swinging over the lead from your VHF/UHF antenna to connect to CON2 of the converter. The HF antenna connects

Worth a try: SinoRadios' TG34 Indoor SW/MW Active Loop Antenna

Considering its low price when purchased via ebay, the TG34 Indoor HF Active Loop Antenna kit offers surprising value for money. Here's what you get:

- A diamond-shaped loop antenna formed from about 1.68m of flexible insulated wire, complete with a telescopic "stretcher" to hold the two centre "corners" apart by about 560mm, plus a tiny RF amplifier located at the bottom of the loop in a heart-shaped case measuring only 25 x 30 x 10mm (WxHxD). The amplifier case has a 3.5mm socket at the bottom, and a sub-miniature slider switch on the front to change between the MW and SW bands.
- A control box measuring 77 x 28 x 15mm, which holds the two AAA cells used to power the RF amplifier, plus an on/off slider switch, a power indicator LED and a small tuning wheel. The control box has a 3.5mm socket for connection to the amplifier case and a captive 400mm-long output lead terminated in a 3.5mm plug.
- A flexible lead 4.57m long with a 3.5mm plug at each end to connect the RF amplifier to the control box.
- A suction cup with a moulded plastic hook, plus a small plastic spring clip with a loop of strong thread, to support the top of the loop antenna when it is mounted on a window or glass door.
- Two different output adaptor leads, to couple the output of the control box into MW/SW receivers which don't have a 3.5mm external SW antenna socket. One of these leads is about 350mm long with a 3.5mm line socket at one end and a pair of plastic alligator clips at the other, for clipping to a receiver's rod antenna and earthing screw. The other lead is only about 80mm long but with a 50mm-long ferrite rod antenna at the far end to magnetically couple into a receiver's own ferrite rod antenna when all else fails.
- A small (160 x 90mm) suede-finish drawstring carry bag, into which all of the TG34 bits and pieces can be placed for users who want to take it on their travels.
- Finally, there's an 80mm CD-ROM with user manuals for the TG34 and other SinoRadios' products, in PDF format.

By the way, the claimed frequency overage of the TG34 on the SW band is from 3.9MHz-22MHz, while on the MW band it's 520kHz-1710kHz.

As you can see, the TG34 seems to be intended primarily for mounting on the inside of a glass window or door using the suction cup and hook arrangement. However, this is by no means the ideal way of mounting a loop antenna, because this type of antenna has a doughnut-shaped response pattern with nulls in either direction along the axis of the loop (ie, at right angles to the plane of the loop itself).

So mounting the loop parallel to a window or door results in minimum sensitivity in the direction perpendicular to the window or door.

In any case whether you're using a loop antenna like this on your travels or in a fixed location like your home, you really need to be able to rotate it in the horizontal plane so that you can find the position which gives best reception of the signals you want to receive.

When I first received my TG34 kit, I tried it out suspended via the suction cup and hook arrangement against a window. The results were actually quite respectable on both

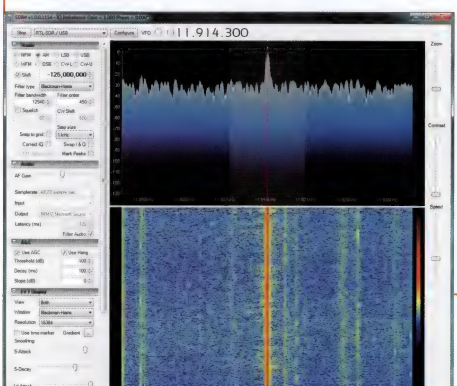


Fig.7: SDR# spectrum & waterfall displays for Radio Australia on 11.9143MHz (AM). Note the -125,000,000 (ie, 125MHz) entry in the Shift dialog, so that the correct tuned frequency is displayed.

to CON1 of the converter – see Fig.1.

That done, connect CON4 to a source of 5V DC; eg, a spare USB port on your PC or a low-power 5V plugpack. When you switch on the 5V power, there should be a tiny "click" as signal switching relay RLY1 activates and connects CON3 and your SDR

the MW and SW bands. The gain provided by the TG34's RF amplifier was very worthwhile and it was quite easy to tune for a peak using the little tuning knob on its control box, using SDR#'s spectrum display as a guide.

All the same, and aware of the shortcomings of the fixed "against the window" location of the loop, I decided to see how much better it might be when mounted on a simple rotatable stand like that shown in the photo.

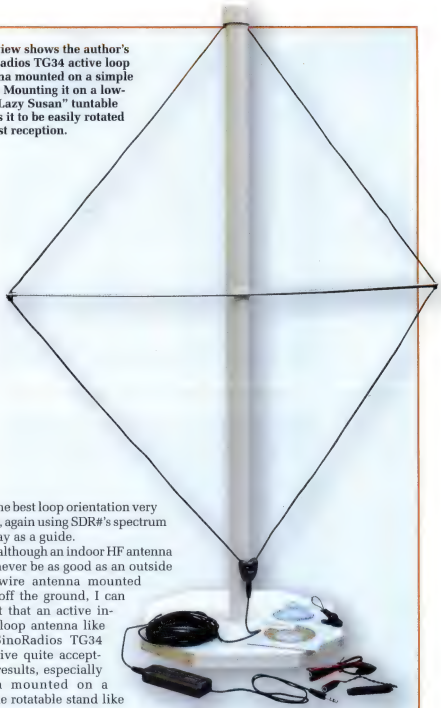
I made the stand from a 750mm length of 27mm OD PVC pipe (cut from a 1m length), with a base made from a piece of 16mm Melamine-covered chipboard. The base was cut into an octagon shape measuring 240 x 240mm, with a 27mm-diameter hole cut (using a hole-saw) in the centre to take the bottom end of the PVC pipe.

Then at the top of the pipe, I sawed and filed two slots diametrically apart, about 3mm wide and 20mm deep. These allowed the top of the loop to be dropped into both slots, before a 27mm ID PVC cap was pushed onto the top of the pipe to hold the loop in place.

The centre of the supplied telescopic spreader was then attached to the PVC pipe using a small patch of double-sided adhesive foam, with another small patch of foam used to attach the little RF amplifier case to the PVC pipe down near the base.

It's very simple but it allows the complete free-standing loop antenna set-up to be placed on a bookshelf, just inside a window, and rotated as desired to optimise reception. I even found a $9 "Lazy Susan" turntable at one of the local bargain stores, which could be placed under the base to allow the antenna to be rotated even more easily.

The results were quite impressive, too. The rotating stand allows you to find the best loop orientation very easily, again using SDR#'s spectrum display as a guide.



This view shows the author's SinoRadios TG34 active loop antenna mounted on a simple stand. Mounting it on a low-cost "Lazy Susan" turntable allows it to be easily rotated for best reception.

So although an indoor HF antenna will never be as good as an outside long-wire antenna mounted well off the ground, I can report that an active indoor loop antenna like the SinoRadios TG34 can give quite acceptable results, especially when mounted on a simple rotatable stand like the one shown.

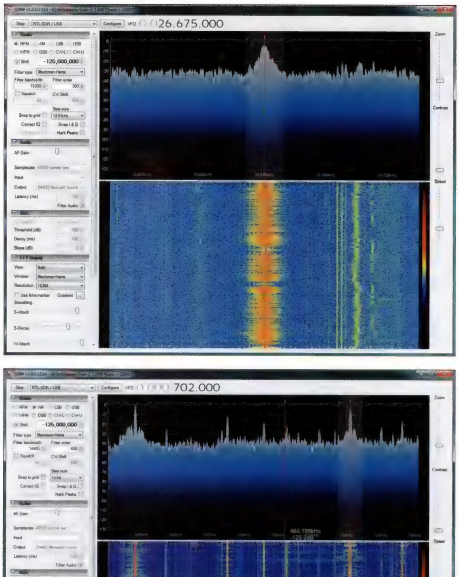
By the way, the TG34 kit can be ordered online via ebay from SinoRadios (http://stores.ebay.com/SinoRadios), who are currently offering it for US$11.99 plus airmail postage of A$11.55 to Australia. So the total cost is about A$22.50, which seems to make it a very good match for our low-cost SDR using a DVB-T dongle and our new Up-Converter.

dongle input to the Up-Converter's output.

If you then start up SDR# (or whatever SDR application you're using), you should start to see signals coming in from the LF-HF part of the spectrum; shifted up into the VHF region, of course.

If you are using SDR#, this won't be a problem provided you have already set the "Shift" frequency (in the Radio section of the control panel at upper left) to a figure of -125,000,000. If you then click in the small square box just to the left of the "Shift" label, the displayed frequency will swing down to indicate the correct frequency of the tuned HF signal.

You're now free to explore the LF, MF and HF bands in the same way as you've been exploring the VHF and UHF bands. And, of course, you can return to looking around on the VHF and UHF bands at any time simply by



Figs.8 & 9: SDR# spectrum and waterfall displays for a 26.675MHz narrow-band FM signal (top) and a 702kHz AM signal (bottom). As in Fig.7, a frequency shift of 125MHz has been entered so that the correct tuned frequency is displayed.

switching off the 5V power to the Up-Converter and clicking again on the box just to the left of SDR#'s "Shift" label, to de-activate the 125MHz downward shift in the display frequency.

By the way, if you want to frequently switch between the two antennas, then it's a good idea to fit an on/off power switch to the Up-Converter.

One small piece of advice: be sure to use a good-quality double-screened PAL-to-PAL patch lead to connect your Up-Converter to the input of your DVB-T dongle. This will allow less ingress of VHF signals (and therefore lower the incidence of spurious signals), than with an "el cheapo" single-screened patch lead. I found this out the hard way!

Which HF antenna to use?

The results you'll achieve using the Up-Converter to explore the LF-HF bands will depend very much on the antenna you use with it. Probably the best type of antenna to use is a long-wire antenna mounted outside your house or apartment, as long as possible and mounted up as high as possible. The input earth to the Up-Converter should also be connected to a good RF earth, eg, by connecting its metal case to the metal chassis of an earthed piece of equiment.

Alternatively, you can connect it to a galvanised metal stake driven into moist ground.

In a lot of cases, this kind of antenna set-up won't be practical though. You may have no way to mount a large outside antenna of any kind and in this situation you'll probably be forced to go for a loop antenna mounted in the nearest window, or a helical-wound "vertical broomstick" antenna mounted as near to the window as possible.

Note that if you go for the helical antenna you'll still need a good earth but this won't be needed if you go for the loop antenna.

Active loop antenna

Even with a plain loop antenna, the results you get will depend on your location and altitude. If these conditions are not very favourable, you might like to try using an active indoor loop antenna, ie, one with an inbuilt RF amplifier and possibly some sort of tuned preselector circuit.

I considered the possibility of developing an active HF antenna of this type but then I looked around on the web (and ebay in particular). There I found a number of complete HF active indoor antenna kits, made in China and available for between $12 and $15 plus postage.

Since you wouldn't be able to build one for such low prices, I quickly decided to forget the idea of a DIY antenna and simply buy one of these Chinese bargains.

The loop I bought was the TG34 from SinoRadios (**http://stores.ebay.com/SinoRadios**), who currently offer it on ebay for US$11.99 plus airmail postage of A$11.55 to Australia. It arrived in my mailbox within one week, for a grand total of A$22.50.

Since then I have been putting it through its paces with my prototype Up-Converters and DVB-T based SDR set-up. The panel on the two preceding pages has the details. SC

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Digital TV: Where to from here?

What has been achieved since we asked this question back in March 2010? There has been a lot of change but in some ways, we've gone backwards! Alan Hughes reports . . .

We have moved from an up-scaled version of the primary Standard Definition (SD) program on commercial TV's High Definition (HD) channel (eg, **OneHD, 7Mate or GEM**) to independent programming between the primary and secondary independent programs in HD (eg, **11, 7Two or GO!**) and another in SD with a third datacasting channel (eg, **TVSN, 4ME, Gold**).

However not all programs on the HD channels are HD originals but are up-scaled SD programs.

The ABC is now carrying 4 channels of programs but has transferred its HD service from the main channel, **ABC1**, to their 24-hour news channel, **ABC24**.

SBS is still simulcasting **SBS1** in HD and SD and has added **SBS2** and **NITV**.

Community TV stations (Logical Channel Number 44) are now all digital on UHF in five of the mainland state capitals.

VAST

The "Viewer Accessed Satellite Television" (VAST) is now carrying, to remote areas of WA and black-spot areas, the same 18 programs as regional WA gets.

The remote Queensland and Northern Territory gets 17 programs in Eastern Time and the balance of the country gets 16 programs in Eastern Daylight Time.

There are also repeats of the regional news from each commercial region as well. This service uses the latest DVB-S2 modulation and MPEG-4 compression for the HD channels.

The older 4-program "Aurora" service which uses DVB-S and MPEG-2 will be closed on 10th December this year. Change-over subsidises have been available for those areas covered by Aurora analog ground-based repeater receivers which will not be converted to digital.

Low-band VHF

All TV transmissions between 45 – 144 MHz (channels 0 – 5A) have now stopped with the exception of the Sydney and Melbourne main ABC transmitters. Even these analog transmitters will cease to transmit on 10th December this year. The 87.5-108MHz FM radio band is now completely clear of TV channels 3-5.

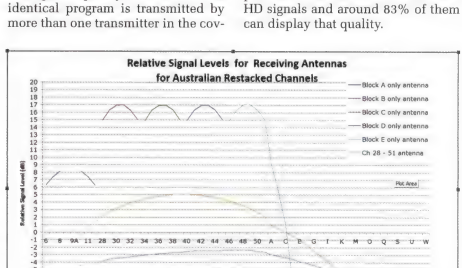
Single Frequency Networks, where identical program is transmitted by more than one transmitter in the coverage area, has been introduced and extended.

Currently they are used in Cairns, Sunshine Coast/Brisbane/Gold Coast, Toowoomba, Newcastle, NSW Central Coast, a pair in Sydney, the Dandenongs, eastern and western sides of Port Phillip Bay. After all, there are only four UHF channel blocks to choose from (as shown in Table 1)!

You're not getting full HD TV!

The Department of Broadband, Communications and Digital Economy runs "Digital Tracker" surveys once per quarter.

The fourth quarter 2012 survey reports that 92% of viewers can receive HD signals and around 83% of them can display that quality.



Relative signals levels including the shortening of the dipole with increasing channel number (not included in manufacturers' specifications). The alphabet channels are used for the Wifi channels which are not wanted.

Summary:

- **From the start of 2014 all primary channels need to be HD and the existing HD channels may become SD.**
- **MPEG4-capable receivers need to become standard.**
- **Analog TV finishes on December 10 2013. The restack (retuning) will be complete by December 10 2014.**
- **TV antennas which are wider than 750mm are still being sold and installed are not suitable for digital TV.**
- **TV antennas should be chosen according to the specific channel block for their site as well as the polarisation used. Block A band 3 VHF; Block B band 4 UHF; Blocks C-E channels 28 - 51 only.**
- **Once the restack is complete in your area there is no need for any dual-band VHF/UHF antennas. There are many dual-band Log Periodic antennas being promoted and sold at the moment. Only a small part of these antennas is being used.**
- **All antennas designed for "analog" or "analog and digital" should be taken off the market because their only use is to pick up analog ABC1 on channel 2 in Sydney and Melbourne which are simulcast in digital anyway.**
- **There are many antennas designed to include channel 52+. They are sensitive to interference from the new wireless data transmitters to start in 2015.**

Initially all HD signals had the potential of 1920 pixels/line and 1080 lines per viewable frame, sent in an interlaced fashion at 25 frames/second. However, now all but ABC24 transmit 1440 x 1080 x 25i, which means that the sharpness of vertical edges in the picture is reduced and diagonal lines and circles have jagged edges.

All but the smallest TV screen sizes capable of receiving are full HD. (1920 x 1080 progressive scan order as mentioned above). But with the broadcasts being interlaced, only half the picture detail is updated at a time.

Full HD is recorded onto Blu-ray discs by the movie manufacturers at 24 frames/second, so now the general public's TVs can display sharper images via Blu-ray than the broadcasters transmit at their best!

Compression systems

These systems reduce the 829 Mbit/s of a full HD picture signal down to around 15Mbit/s for transmission.

MPEG-2 (also called H262) is used throughout our TV broadcast system with the exception of VAST HD satellite transmission.

MPEG-4 (also called H264 or MP4) was standardised six years ago. It produces half the data rate signal for the same image quality as compared to MPEG-2.

MPEG-4 is used in most Blu-ray movies, in many countries, (with the exception of North America but including NZ) for broadcast TV, VAST HD and Foxtel HD. It was also used in Australia for the 3-D transmission of the Olympics, World Cup Soccer and Rugby League grand finals. MPEG-4 was added to Australian Standard "4933.1 Digital television – Requirements for receivers" in 2010.

Sony has stated publically that all its receivers from 2009 have been capable of MPEG-4 reception and virtually all Personal Video Recorders (PVRs) are also MPEG-4 capable.

No other manufacturers have made any comment and the compression type is missing from nearly all manufacturers' specifications. The number of capable receivers is unknown.

What needs to be achieved by the end of this year?

It is an ACMA requirement that real HD (not upscaled SD) has to be broadcast for 1040 hours per year (3 hours/day) by each broadcaster. But this requirement ends 10th December, the same time as the last analog TV signals cease.

Considering that viewers have collectively invested a lot more money than the broadcasters in buying new full HD receivers, the broadcasters need to broadcast their most popular programs in HD, just as is done in the USA and the UK.

We know that the audience is equipped to receive it so – **ONE** (using TEN's programs), **ABC1, SBS1, Southern Cross, Prime/GWN, Seven, WIN/NBN/Imparja** and **Nine** should be switched to HD and the original **ONE** (to be called 10), **ABC24, 7mate** and **GEM** become SD.

SBS1 in SD stops transmission. This means that the HD programs can be selected with a single button push on the remote control.

The ability of the audience to receive MPEG-4 needs to be determined.

The DBCDE Digital Tracker surveys will only occur for the third and final quarters of this year. They could be used to determine the percentage of MPEG-4 capable receivers.

This can be done by stopping the SBS1 simulcast in Adelaide, Perth and Brisbane and replacing SBS1 SD with an MPEG-4 compressed full HD signal containing an electronically moving square along with an identifying caption.

This produces an image in which smooth motion can be seen – and the data required for such an image is small enough not to exceed the data rate for a normal SD program.

This could also be transmitted on ABC3 between 9:01 PM and 06:00 AM (the time it is currently off-air) in SD.

We are now getting video transmission rates of SD which are approaching sound data rates so we also need to test if receivers are capable of Advanced Audio Compression (AAC-V2) which could be tested at the same time.

One on-line retailer is selling a Set Top Box/Recorder for $22 + $9 postage, while a chain store is selling a similar product of the shelf for $39.

If all programs are transmitted in MPEG-4, a Personal Video Recorder will be able to record twice as much programming on its hard drive, as the transmission data rate has been halved.

This survey could also be used to test if receivers can display Full HD pictures using progressive scanned signals and 24 frame/s video to give us movies without the increase in sound pitch and reduced length.

This six-element Yagi antenna has all its elements about the same length giving maximum sensitivity and directivity to a small range of channels. This VHF-only type would be typically used in most state capitals post-December 10.

What needs to be achieved by the near future?

The www.digitalready.gov.au website uses propagation software to estimate the signal strength at any street address in Australia.

It has been backed up by an ACMA physical signal strength survey.

It has resulted in many new translator sites to fill in black spots. Most will require channel changes when the restack occurs for each site.

DVB-T2 is a new modulation technique which doubles the data carrying capacity of a transmission channel over our present DVB-T system. It also allows rugged transmission to hand-held devices without paying a telecommunications company if a compatible demodulation integrated circuit is installed.

This modulation technique is being used in the UK to carry five full HD programs on a single transmitter. These programs are MPEG-4 compressed. DVB-T2/MPEG-4 set top boxes are available overseas.

Stereoscopic or 3-D TV compression standard H265 was standardised in January and produces a data stream a quarter of the size we currently use on air.

Combined with the DVB-T2 doubling the transmission channel capacity, this gives enough data width to transmit full HD S-3D signals to all TVs.

The S-3D signal consists of a standard two-dimensional signal along with a depth signal telling 3D TVs how far the object is away.

Digital restack

The digital restack has commenced and will be completed by the end of next year. It will be used to sell TV channels 52 – 69 to the wireless data industry for LTE data transmission.

It is a process of moving all transmitters on a single site on to one of the channel blocks as shown in Table 1 below.

A restack example on the main transmitter sites in the mainland state capital cities: SBS will start transmission on transmission channel 7 as soon as 7 analog has switched off and in Sydney and Melbourne's case switch off their UHF digital transmitter three months later.

This is to allow antenna installers time to retune or replace channel amplifiers in multi-dwelling units (MATV systems).

All TVs will need to have a channel search done to find SBS's new transmission channels. Viewers using translators will need to do a channel search on other dates.

The implications on new receiving antennas of the restack is that there will be no need for VHF/UHF antennas or for cross-polarised antennas as used in Canberra, Goulburn Valley Vic, Manning River NSW, and Gladstone East Qld.

Note that on top of this if you double the number of elements the gain only rises 3dB, so tuning the antenna to the block of six channels drastically improves antenna performance for the desired channels and rejects all other surrounding signals in frequency.

Contrast this to a "log periodic" antenna designed for Australian channels 6 – 12, 20 – 75. One of these is shown opposite.

AS1417.1(Int)-2011 "Receiving antennas for radio and television in the VHF and UHF broadcast bands" ran out on 24th February and is yet to be completed.

It needs to ban the sale of any TV antenna designed for coverage of any frequency below 176MHz, the lower edge of our channel 6, and above 694MHz the upper edge of channel 51. (European channels 5 – 48).

These antennas are still being installed as I write for transmissions which don't (or shortly won't) exist.

Community TV (channel 44)

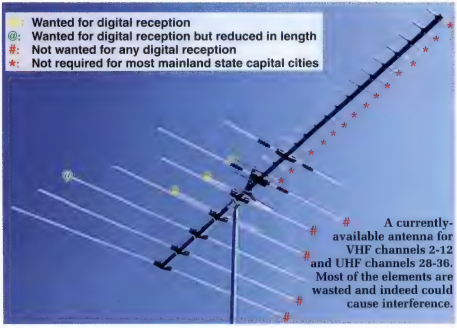
Community TV (channel 44) in mainland state capitals transmits in Band 4, UHF.

There has been no decision by the DBCDE/ACMA as to whether they will be restacked to transmission channel 10, or share with SBS to allow translators to operate in black holes in the coverage area such as CBD Sydney, Melbourne, Perth, Geelong, Kings Cross, Sydney's northern beaches, the Dandenongs and the Adelaide hills as examples.

Restack channel blocks — Transmission channels for 2 government, 3 commercial and 1 unallocated (but will be used for community TV in some locations). Each transmitter site is allocated only one block of channels – the same polarisation will be used for all transmissions from that site.

A (VHF)	6	7	8	10	11	12
B (UHF)	28	29	30	31	32	33
C (UHF)	34	35	36	37	38	39
D (UHF)	40	41	43	43	44	45
E (UHF)	46	47	48	49	50	51

Table 1: the ACMA restack block channel allocations. All transmitters have the same transmission characteristics. A 6MHz guard band above channel 51 is being used to prevent TV interfering with WiFi and vice-versa. Note: TV stations transmit a logical channel number such as channel 2 for ABC1, even if the receiver is physically tuned to any of the channels in the table. This transmission channel tuning occurs during installation or channel search.



Currently the only translator is for South Yarra (Melbourne) and has only a tiny power output.

What needs to be achieved by the end of next year?

We need to include now in Australian Standards 4933.1 "Digital television – Requirements for receivers and AS 4599.1-2011 Digital television – Terrestrial broadcasting – Characteristics of digital terrestrial television transmissions" a requirement for DVB-T2 with AAC-V2 surround sound in all receivers from next year and for all the transmitters to be capable within five years. In addition, H.265 compression needs to be specified as soon as decompression integrated circuits become available.

Note existing receivers cannot produce a viewable signal from a DVB-T2 signal and H265 decompressor will be combined with MPEG-4/MPEG-2 decompression integrated circuit. Software versions can be added to existing computers and phones.

Lastly, the Australian Standards referred to above need to be made mandatory for manufacturers and importers to allow improvements for the minimum price, at the maximum speed and without the need for subsidies. The ACMA has the ability to make Australian Standards mandatory.

With the introduction of DVB-T2 modulation the TV transmission network will carry around 276Mbit/s of one-way simultaneous information flow.

This is compared to the NBN (National Broadband Network) which has a maximum of 100Mbit/s per household, however the speed will depend on traffic, particularly if many viewers are watching the same program.

DTV transmission is cheaper for many viewers watching the same program whereas the NBN is designed for View on Demand where the viewers are all watching different programs simultaneously.

H265 and the use of non-frame compatible stereoscopic 3-D TV can be carried on terrestrial broadcast, fibre optic internet or satellite TV, which is in order of cost.

We live in technically exciting times. Suppliers of TV equipment, antennas and the broadcasters themselves have been given adequate notice of switchover dates. **SC**

WHEN IS THE BIG SWITCH?

If TV in your area hasn't yet changed and you'd like to know when it will and what to, visit: **www.dbcde.gov.au/__data/assets/pdf_file/0010/161011/Channel_change_timetable_for_Web_-_March_2013.pdf**

Mainland State Capital City Area Translators

Adelaide	Perth	Brisbane	Sydney	Melbourne
Adelaide Foothills (CH)	Roleystone (DH)	Boonah (DV)	Bouddi (DEV)	Ferntree Gully (DH)
Angaston (CH)	Lancelin (DH)	Brisbane NW (DV)	Gosford (DEH)	*Anglesea/Aireys Inlet* (BH)
Cape Jervis (DV)	*Mandurah/Singleton* (BV)	Brisbane SE (BV)	Kings Cross (BH)	*Geelong* (EH)
Carrickalinga (EH)	*Perth City* (EH)	Canungra (BH)	Manly/Mosman (BH)	*Healesville* (CV)
Craigmore/Hillbank (CV)	*Perth Coastal* (EH)	Currumbin (DV)	*Picton* (DV)	Marysville (CH)
Elisabeth South (BV)*	Toodyay (EH)	Esk (CV)	*Sydney NW* (BH)	*Melbourne inner suburbs* (DV)
Eudunda (CV)	*Two Rocks* (B)	Gold Coast (DEH)	*Sydney SW* (DH)	*Monbulk* (EV)
Gumeracha (EH)		Gold Coast South (CDH)	*Woronora* (DV)	*Ocean Grove* (DH)
Lyndoch (CV)		Kooralbyn (BV)	Wyong (DEV)	Rosebud (DV)
Maitland (EV)		Maroon (EH)		Safety Beach (DH)
Mannum (DH)		Mount Alford (EV)		Selby (CH)
Myponga (DV)		*Rathdowney* (BV)		South Yarra (DV)
Normanville (CV)		Sunshine Coast Sth (CH)		Upwey (CV)
Strathalbyn (DV)				Warburton (CH)
Swan Reach (CH)				*Wye River* (CV)
Victor Harbour (CV)	First letter(s) in parentheses are block used. Last letter is polarisation – horizontal or vertical			
Yankalilla (DH)	* No commercials or community TV on this site *Italics* may be a new site			

About Wireless Microphones and Digital TV

by Ross Tester

Wireless (aka cordless) microphones are used in their countless thousands around the country. Pretty much every hall, church, theatre, gym, sporting body . . . you name it – they use, or have used, one or more wireless microphones.

VHF Wireless Microphones

Until the last few years, most wireless microphones were on the VHF bands. Some very low power (10µW) "toys" were on the FM radio bands but these had the unfortunate habit of being swamped by FM radio stations – especially given the proliferation of those in recent times.

Most of the rest used "unoccupied" upper-VHF TV frequencies but once digital TV started, most of those unoccupied frequencies became occupied, especially in capital cities! Scratch the vast majority of VHF wireless mics.

There was (and we believe remains) a *very* tiny portion of VHF spectrum, just a couple of MHz, which according to ACMA, the government body which controls these things, may still available for VHF wireless mics. But we'd be most reluctant to recommend anyone purchase a VHF wireless mic even in that tiny band (just above 200MHz) – it could be changed at any time.

Wireless microphones are legal in this country under what is known as a "LIPD" class licence – that stands for low interference potential device. Part of the LIPD licence requirement is that users not only must NOT cause interference to other licenced users on that frequency but even more importantly have no recourse whatsoever if they are *caused* interference by other licenced users.

And given the fact that most wireless microphones have around 3-10mW output power and those other licensed users might range up to a million watts or more (eg, some analog TV stations), guess who wins!

If the picture shows a telescopic whip antenna (like this one) you can almost certainly assume it is a VHF model. Don't buy it!

STOP PRESS!

As this issue went to press, ACMA put out a media statement to further clarify the wireless microphone issue. You can view this at www.acma.gov.au/WEB/STANDARD/pc=PC_600208

UHF Wireless Microphones

Which brings us to another sticking point. UHF Wireless Mics have become the "norm" in recent years, for the most part occupying the UHF spectrum from 520MHz through to 820MHz (and some "pro" models higher; – 915-928MHz).

That hasn't been a problem – until now!

Digital TV, once again, has become the nemesis.

As you would know, in most areas of Australia – and in all areas by December 10 this year – analog TV will cease. Either you will have bought a new digital TV or a digital set-top-box to feed your old analog TV . . . or you'll be puzzling at the snowy non-picture on your set.

That's the good news, believe it or not. The bad news is that even the digital TV stations currently transmitting in the "high" UHF band (band V), from 694 to 820MHz, have moved/are moving/will be moved down to the "low" UHF band (band IV) from 520 to 694MHz (TV channels 28-35).

"Fantastic", you say. "No more interference to wireless microphones above 694MHz."

You're right – there won't be (from digital TV, anyway). But that's not good news either. The Government auctioned off the newly-vacant high UHF spectrum during April/May 2013 for mobile phone/data services. They've called it the "Digital Dividend". And you can bet that if you've just paid millions of dollars for spectrum space, you won't look too kindly on a gym instructor, preacher or sports announcer interfering with your customers' reception.

In fact, ACMA have already stated that high-band UHF wireless microphones will not be permitted (the class licence will be withdrawn) once the Digital Dividend is sold.

So where does that leave users?

Unfortunately, to a large degree, out in the cold – definitely if you have a band V UHF wireless microphone and possibly even if you have a low-band model.

Quite simply, wireless mics on frequencies above 694MHz are destined for the bin. The vast majority cannot be modified to be operated in a legal way; even if they could, the cost could well be prohibitive.

If you have a band IV UHF model which coincides with a digital TV station in your area, the same comments apply.

What you need to do between now and next year is check to see if your frequency/ies are or are not on a digital TV station around your area. If not, you may be in the clear.

The digital TV bandplan (and much more information besides!) is available on the ACMA website (www.acma.gov.au).

If you're in a country area, you're arguably better off because of the lower number of digital TV transmitters/translators in the country versus the capital cities. But even then, if you suffer interference, bad luck! (You might be able to flog your gear off to someone away from your area with a different digital TV setup).

Some five years ago (December 2008 to be precise), Free

The rules are changing – don't be caught out by rogue traders!

TV Australia published an amazingly detailed document which showed – down to the postcode – the areas where wireless microphones were allowed and where they were not, dependent on their operating frequency(ies).

The beauty of this guide, which came under the moniker of "Operational Practice OP-27 – Operation of Wireless Microphones in the television broadcast channels", was that it listed all areas in Australia with the TV channels being used and which frequency wireless mics could and could not be used in those areas.

As we said, this was back in 2008, long before the Digital Dividend and TV channel re-stacking, so it's almost certain that the information is out of date. And we haven't been able to find a more recent document.

But it is a good place to start – and gives you some idea of the complexity of this whole subject! If you're interested, you can download the 85-page OP-27 PDF from: **www.freetv.com.au/media/Engineering/OP_27_-%20_Issue_3_-_Operation_of_Wireless_Microphones_in_the_Television_Broadcasting_Channels_-_December_2008.pdf**

(It may be easier to log onto the FreeTV website, click on Operational Practices and scroll down to OP27).

It's worthwhile pointing out one comment made in that OP: ACMA have licenced a large number of "self-help" very-low-power TV translators for "black spot" coverage – and these are not covered in the listings. Under the LIPD class licence, you cannot cause interference to these translators either and must suffer any interference they cause.

Because analog TV sound is transmitted as FM, any wireless mic receiver on (or even near) the same frequency will pick up the audio from the TV transmitter. Indeed, because of "capture effect" of FM, the receiver will automatically grab the strongest signal – and if that's the TV translator, so be it!

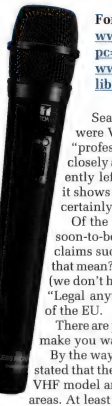
OK, so why are soon-to-be-useless wireless mics still available?

A very good question. Unfortunately, the answer is not so good! Most suppliers are well aware of the impending changes and many are desperate to unload what will be useless stock as soon as they can to "mug punters".

Changes are also happening in the US and many European countries so a lot of overseas stock is being offered in Australia at apparently bargain prices.

It's the old story. A little (or no!) knowledge is a dangerous thing. If you don't know what to ask, they won't volunteer the information. And why would the secretary or treasurer of a local church or sporting group, asked to buy a new wireless microphone, have any idea that he/she was being sold a pup?

For example, take a look at "wireless microphones" on ebay. At the time of writing, there were 1796 wireless microphones being offered – the vast majority from overseas.



For more detailed information: see www.acma.gov.au/WEB/STANDARD/pc=PC_312475 and www.acma.gov.au/webwr/_assets/main/lib100059/geninfo.pdf

Searching through these, probably half were VHF (some actually being advertised as "professional VHF"). Others you had to look closely at to tell because the advertiser conveniently left that part out. If there's a picture and it shows a telescopic (whip) antenna, it's almost certainly a VHF model.

Of the rest, all but five (yes ***five***!) were in the soon-to-be withdrawn high-band UHF. Beware of claims such as "Australian Standard" (what does that mean?). Or "New FCC Approved Frequencies" (we don't happen to have an FCC in Australia!). Or "Legal anywhere in EU" – we aren't exactly part of the EU.

There are plenty of other puff words which should make you wary.

By the way, congratulations to the ebay seller who stated that the used wireless mic he was selling was a VHF model and might not be usable in metropolitan areas. At least one honest trader!

Our tip: if you're in the market for a wireless microphone, be very careful about buying on line – ebay or any other source. If you do, check it out thoroughly – if the advertiser doesn't list the frequency of operation, don't buy it. You could do your dough!

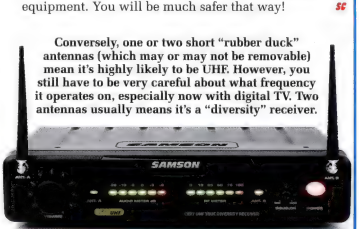
As an exercise, we sent a message to several advertisers asking what the frequency/ies of operation were. Some didn't respond, some were very vague and some even quoted the audio frequency range. Helpful – not!

So what to do?

If you are buying locally/retail, ask the supplier to guarantee ***in writing*** that the model you are buying will be suitable for use in your area after 2014. Fair-dinkum suppliers should be able to do so. We wouldn't be buying from an online supplier (particularly from overseas).

But realistically, until there is some definitive guide on what will and what won't be usable in your area, if possible we'd defer buying any new wireless microphone equipment. You will be much safer that way!

Conversely, one or two short "rubber duck" antennas (which may or may not be removable) mean it's highly likely to be UHF. However, you still have to be very careful about what frequency it operates on, especially now with digital TV. Two antennas usually means it's a "diversity" receiver.



GW-Instek GDS-2104A 100MHz 2GS/s 4-channel digital oscilloscope

Review by LEO SIMPSON

Digital oscilloscopes continue to become far more powerful and yet cheaper, as illustrated by the release of the GW-Instek range of digital scopes with variable persistence display. Available in 2 and 4-channel versions with bandwidths ranging from 70MHz to 300MHz, they are easy to drive and have a great range of features.

Our review scope was the GW GDS-2104A 4-channel 100MHz model which was fitted with optional plug-ins for a 16-channel logic analyser and a 2-channel function generator, making it a mixed signal (ie, analog & digital) scope with a built-in signal generator which can provide sine, square or triangle waveforms.

By the way, GW-Instek will be familiar to many readers, with GW standing for the well-known brand-name Goodwill.

Features of the scope include a maximum sampling rate of 2GS/second (depending on timebase setting), vertical input range of 1mV/div to 10V/div, timebase range of 1ns/div to 100 seconds/div and a waveform update rate of 80,000/second.

It has built-in segmented memory and waveform search options and you have a Zoom window and play/pause to navigate the waveforms. Control via USB is a standard feature while LAN and GPIB are options.

Out of the box, the GW scope impresses with its large 8-inch diagonal (160 x 120mm) screen and its well laid out control panel which has all knobs and buttons nicely spaced and clearly labelled.

The four BNC probe sockets are not probe-sensing (ie, they don't sense the probe's division ratio and alter the vertical sensitivity accordingly) but it is easy to set the probe division ratio at anywhere between 1X and 1000X in a 1:2:5 sequence with the "Variable" knob once you press one of the channel buttons.

Doing so brings up all the relevant input parameters: coupling (AC, DC or GND), Impedance (fixed, in this model), Invert (on or off), Bandwidth (20MHz or unlimited), Expand, Vertical position and Probe voltage.

The last of these seven soft-buttons (below the screen), also gives the option of selecting voltage or current as the measured parameter and also allows you to compensate for tiny cable propagation delays in the picosecond or nanosecond range.

Incidentally, I should apologise for launching into detailed description of just a few features because that's how it is with modern digital scopes: pressing a button invariably brings up menus on-screen which you select from with the soft-buttons and then adjust with "Variable" control in the top left-hand corner of the control panel. It is fairly intuitive and if you do become lost, a Help button will give a brief description of the function that you are playing with.

As another aside, I must say that I am quite conscious of the scope's noisy fan in my quiet office as I write this review. This is not generally noticeable in a typical lab or workshop but now that computer fans are generally very quiet, should this one be so audible?

One of the best features of this scope is the bright TFT LCD colour screen which has a resolution of 600 x 400 pixels. It gives a good clear display but some people may find the screen fonts a bit small – you will need your glasses in this case. Partly that's because the designers have crammed in lots of on-screen functions.

For example, you can display up to eight measurements from a selection of 36. Then you can add statistics to all those measurements (ie, mean, Min, Max and Standard Deviation).

At the same time you get the selection menu down the right-hand side of the screen, vertical and horizontal settings along the bottom screen edge and triggering and date info at the top.

With all that displayed simultaneously, less than half the screen is available to show the signals! So lots of info can be shown. You can then remove a lot of it by pressing the "menu off" button.

A really good feature of the Goodwill scope is that it has three Demo waveform terminals just below the right-hand corner of the screen. One of these is the standard 1kHz square wave for probe calibration. The second waveform is a pulsed 100kHz square wave and the third is frequency-modulated waveform.

These would be very handy for demonstrating how to use the sync func-

tions of the scope as well as just learning your way around it if you have just purchased it.

By the way, if you want an output for an external monitor on the rear scope, you need to choose plug-in LAN module option. Besides an ethernet socket, that gives you an SVGA output for display on a projector or monitor.

Sync functions are very comprehensive, with edge, delayed triggering, pulse width, video, as well as runt pulse, rise & fall and time-out.

Mind you, since most video dis-

The rear of the GW-Instek scope has two USB ports, one for a printer and the other for control functions via USB. It also has BNC sockets for a Cal output and a Go/No go test function.

plays these days tend to be flat panels rather than CRT-based, most of the video triggering facilities (eg, PAL, NTSC & SECAM) will probably never be used in most cases.

Four 100MHz probes are supplied with the scope and they are switchable between x1 & x10.

As noted above, you do need to select the probe division ratio which you can do by bringing up the channel input menu, after selecting the relevant Channel Input button.

The optional 2-channel function generator, 16-channel Logic Analyser and LAN modules (plugged into the back of the scope) are selected by pushing the front panel "options" button. We had both the Logic Analyser and Function modules installed but the Logic Analyser option is "greyed out", until the 16-channel connector is plugged into the front panel.

The LAN option is similarly "greyed out unless the module is plugged into the back.

Incidentally, while the GW scope comes with a very comprehensive instruction 258-page manual on CD, we did not have access at the time of writing for the 16-channel logic analyser or the function generator manuals.

The function generator is quite impressive though, able to deliver sine, triangle and square waveforms with the duty cycle of variable and frequency variable from much less than 1Hz to 5MHz and with very fine control available.

Want a frequency of 3.567867MHz? Just dial it in as you can precisely set each decade. Note that you can use the function generator and the logic analyser simultaneously and you can do analysis and decoding of parallel and serial buses such as I^2C, SPI and UART (with the module installed, of course).

A USB socket on the front panel allows waveforms to be saved in .JPG or .PNG format while a USB socket on the rear panel allows a (Pictbridge) printer to directly print out screen grabs.

Overall, we were very impressed with this scope although we only had it for a couple of days – not really enough time to explore all that it can do.

Three models are available in the GDS2000A series: GDS2072A, 70MHz 2-channel @ $895.00; GDS2104A, 100MHz 4-channel @ $1599.00 and GDS2304A, 300MHz 4-channel unit @ $2599.00.

The optional plug-in modules are the DS2-FGN 2-channel 5MHz Function Generator @ $229.00; the DS2-16LA 16-channel Logic Analyser @ $745.00 and the DS2-LAN, Ethernet and SVGA output @ $259.00. All prices exclude GST.

The pockets on the rear panel are there to accommodate two out of a choice of three plug-in module options: the 16-channel, Logic Analyser, the 2-channel Function Generator or the Ethernet & SVGA output module.

For further information, contact Tekmark Australia Pty, Ltd. Phone (02) 9911 3888 or 1300 811 355 or see their website at www.tekmark.net.au

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Multifunction Environment Meter

Combines the functions of a sound level meter, light meter, humidity meter and temperature meter.

- 4000 count
- Cat III 300V
- Size: 170(H) x 78(W) x 48(D)mm

QM-1594 *was $99.00*

10% OFF all DMMs this month

$89.10 SAVE $9.90

SEE MORE DMMs ON PAGE 5

4Ch DVR Kit with 4 x 420TV Line CCD Cameras

Ideal for any small business or residential location, allowing you to view live or recorded footage from 4 cameras on an existing TV or computer screen. Also allows remote access via the internet or through an iPhone® or Smartphone app. Package contains a full function DVR, four high quality weatherproof CCD cameras, camera cables, and a pre-installed 500GB HDD. See instore for details.

- H.264 video compression
- Up to 704 x 576 pixel (D1) resolution
- 420TV Line CCD cameras
- DVR size: 343(W) x 240(D) x 68(H)mm

QV-8106 *was $649.00*

500GB HDD included

15% OFF on selected DVR Kits

Wireless 2.4GHz Digital Reversing Camera Kit

To be used in trucks, buses and other large vehicles with big blind spots. Uses DIGITAL 2.4GHz for transmission of uncorrupted video data and better range. Both the camera and monitor are fitted to tough aluminium mounting brackets with sun shades, however they can be removed if a different mounting method is preferred. The system supports expansion up to 4 cameras (additional camera available separately **QM-3805 $199**).

- 7-inch TFT LCD Colour Monitor
- 800 x 480 Resolution
- Power supply: 12V - 24VDC
- 1/4" Sharp CCD Camera
- 420TV Lines

QM-3804

NEW $399.00

Flexible Adhesive LED Strip Lights

300 x 5050 SMD LEDs on a 5m strip for installation in foyers, cinemas, or around the house. Backed with an adhesive tape for easy mounting and can be cut to desired length.

- 12V

5m Cool White
ZD-0575 $69.95

5m Warm White
ZD-0577 $69.95

NEW $69.95 ROLL

$549.00 SAVE $100

Limited Stock. Not Available Online.

Compact Stereo Amplifier

Simply connect audio to the stereo RCA or 3.5mm line input then connect speakers to the push down spring terminals with power. Features a 6.5mm mic input, making it ideal for a small office or workshop PA system. Mains adaptor included

- Power output: 2 x 25WRMS
- Output impedance: 4 to 8 ohms
- Size: 216(W) x 65(H) x 150(D)mm

AA-0486 *was $99.95*

$89.95 SAVE $10

Rechargeable Waterproof Bluetooth® Speaker

Pair with a Smartphone and listen to music easily and have phone conversations through the speaker thanks to the built-in microphone. It even floats if it falls in the pool.

- Rubberised edges and handles
- 10 hour playtime
- Size: 230(L) x 102(W) x 67(D)mm

XC-5208

Note: iPhone® not included

NEW $119.00

Filter Your TV Reception!

A large part of the TV spectrum in Australia is being reallocated to mobile phone services (for LTE Technology). This means that future mobile phone services may interfere with your TV reception. You can eliminate this problem by inserting this filter into the antenna input line of your TV. No power supply required.

- F type connectors
- Freq. Range: 5-694MHz
- Size: 47(L) x 21(Dia.)mm

LT-3061

NEW $24.95

STRATHPINE, QLD

NOW OPEN

Corner Bells Pocket & Gympie Rd, 4500

Ph: (07) 3889 6910

Ample parking available right outside!

12VDC Air Flow Compressors

Pump up car tyres, bike and other inflatables when you're out an about. Features themal cut-out protection, cleanable air filters to keep the units free from contaminants, as well as anti-vibration mounting feet. Connect to your 12VDC power source with the supplied heavy duty battery clamps.

72L/Min
MC-7202

NEW $99.00

180L/Min
MC-7200

NEW $199.00

DUE EARLY JUNE

MC-7200

Economy 4 Channel DVR

Features 4 channel multiplexer, Ethernet functions, and H.264 video compression. It delivers D1 resolution video (704 x 576) at 100 frames per second. Playback can be displayed locally through the composite or VGA outputs and remotely via a network connection using a web browser or an iPhone®, iPad®, or Smartphone app. Supplied with a 500GB HDD fitted, software and manual on CD, power supply, and quick start guide.

- Built-in web server for network access
- Size: 375(W) x 285(D) x 45(H)mm

QV-8120 *was $399.00*

$349.00 SAVE $50

Also available: *16-Channel D1 Resolution DVR*
QV-8122 *was $899.00 now $849.00 save $50*

Solar Rechargeable Sensor Spotlight with Announcer

A simple method for adding a level of security in areas where no mains is available. Comes with a solar panel, sensor spotlight with PIR, and a wireless announcer.

- 500 lumens
- Tough ABS housing
- CREE® XML LED
- 100m range
- Size: 240(H) x 110(W) x 150(D)mm

SL-3236

NEW $129.00

Also available

Solar Rechargeable Sensor Spotlight

Choose this model if you have no requirement for the wireless announcer contained in SL-3236.

- Size: 240(H) x 110(W) x 150(D)mm

SL-3234

NEW $99.00

Emergency Light with PIR

We also stock a mains powered version without a wireless announcer.

- Size: 240(H) x 110(W) x 150(D)mm

SL-3232

NEW $69.95

Steelmate Entry Level Car Alarm

An affordable car alarm that features voice feedback on alarm status and operational parameters such as open doors etc. Comes with code hopping remotes. Other features include boot release button, valet mode, and manual override.

LA-9003 ***was $99.00***

$79.00 SAVE $20

Pro Style Surveillance Cameras

- 550TV lines
- Works on 12VDC or 24VAC
- Lens and power supplies sold separately

ExView Colour CCD Camera

High resolution Sony® ExView HAD CCD-equipped camera to dramatically improve low-light performance.

- Perfect for use with infra-red illuminators

QC-8622 ***was $249.00***

$179.00 SAVE $70

Dual Voltage CCD Camera

Professional grade wide dynamic range camera based around Sony's SS2 vertical double-density wide dynamic range CCD system. It provides a high quality picture in conditions, which would render most other cameras' output useless.

QC-8623 ***was $299.00***

$179.00 SAVE $120

Save 15% Off on Selected DVR Kits

View live and/or recorded footage anytime, anywhere!

Network 4Ch DVR with 4 x 520TV Line CCD Cameras

Contains multiplexing DVR with Ethernet access, four weatherproof CCD cameras with IR illumination, and four 20m cables.

- 704 x 576 D1 resolution @ 100fps
- 500GB SATA Hard disk
- 520TV line cameras
- CCD cameras provide clearer images at night time
- DVR size: 343(W) x 240(D) x 68(H)mm

QV-8108 ***was $649.00***

$549.00 SAVE $100

Limited stock.

Network 4Ch 10" LCD DVR with 2 CMOS Cameras

This 4 channel network DVR has a 320GB HDD, a 10" LCD and 2 x 350TVL cameras. Easy to install!

- H.264 Compression
- 350TV Lines CMOS camera
- DVR size: 208(L) x 85(W) x 242(H)mm

QV-3030 ***was $449.00***

$379.00 SAVE $70

See page 1 for more DVRs

Limited stock.

Camera Detector

Detect covert cameras and listening devices with this handy little unit. It uses 6 pulsing LEDs to reveal the location of a camera by illuminating its lens when you look through the lens viewer from up to 10m away. Earphones supplied for discrete use.

- Built-in wireless RF detector with audible buzzer
- Requires 2 x AAA batteries
- Size: 85(H) x 56(W) x 18(D)mm

QC-3506

$99.00

Motion Sensor Alarm with Solar Panel

Protect your home or office space with this simple and easy to use alarm. Triggers the siren once movement is detected up to 8m away. The solar panel is sufficient for daytime arming and uses backup battery power for night time.

- 130dB siren
- 3 x AA batteries required for night operation
- Mounting hardware included
- Size: 116(H) x 70(W) x 33(D)mm

LA-5216

$16.95

Limited Stock. Not Available Online.

8" Colour LCD Doorphone System with 4-Channel Recording

The 8-inch, high resolution LCD screen connects up to two intercom/camera units and has a built-in DVR with four camera input. The monitor can display a multi-way split screen view, or auto-switch between channels. A 500GB hard drive is included for storage and to keep a record of who's coming and going. Supports manual, motion detection, visitor call and loop coverage recording functions and also features remote access over Ethernet or Internet.

- Mains power supply included
- Monitor size: 210(H) x 250(W) x 35(D)mm

QC-3628 ***was $549.00***

$499.00 SAVE $50

Additional security cameras also available QC-3629 $79.00

Digital Wireless Surveillance Camera Kits

Easy to install surveillance systems for the home or office, which use 2.4GHz DIGITAL technology to minimize interference and maximise range. Available with a rechargeable 7" LCD screen receiver for viewing video on the go or with standard receiver for connection to an existing TV screen. Both versions can also record video to playback after an incident by adding an SD card (sold separately). Power supplies included.

Receiver Features:

- Quad camera or single camera view
- Supports up to 4 cameras
- Accepts SD cards up to 32GB (sold separately)
- AV output for connection to separate monitor

Camera Features:

- Range up to 100m line of sight
- CMOS 380TV Lines
- IR illumination distance up to 5m
- Weatherproof IP66 housing
- Size: 130(L) x 65(Dia)mm

Additional cameras available separately

QC-3674 ***was $149.00 now $119.00 save $30***

Camera with LCD Receiver

- 7" LCD screen
- Includes a rechargeable Li-ion battery
- Size: 190(W) x 113(H) x 20(D)mm

QC-3670 ***was $349.00 now $299.00 save $50***

Camera with Standard Receiver

- Size:113(L) x 113(W) x 20(H)mm

QC-3672 ***was $249.00 now $199.00 save $50***

FROM $199.00 SAVE $50

QC-3672

QC-3670

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/06/2013.

USB 3.0 Gigabit Ethernet Adaptor

Provides a high performance 10/100/1000Mbps Ethernet connection for your laptop, desktop, MacBook® or Tablet.

- Supports Windows 2000 /XP/Vista/7/ 8 (32/64-bit), Linux/Android, MAC® OS 10.6/10.7
- Size: 45(L) x 25(W) x 15(H)mm

YN-8408

NEW $49.95

DUE EARLY JUNE

Dual HDD 2.5"/3.5" SATA Dock with Offline Clone Function

This dual SATA dock will accept 2 x 2.5" or 2 x 3.5" (or one of each) SATA HDDs/SSDs. Just dock a drive with a complete install of an operating system, dock an empty drive and press the big red clone button. It can also be used as a regular SATA dock for quickly grabbing data off your collection of SATA drives.

- Size: 125(L) x 112(W) x 60(H)mm

XC-4695 *was $79.95*

$49.95 SAVE $30

Note: HDDs not included

Firewire® IEEE1394 Leads

Allows users to attach camcorders, VCRs DVD and other AV components to their computers and printers.

- Male to male

4 Pin to 4 Pin 2m
WC-7640 *was $12.95*
now $7.95 save $5.00

4 Pin to 4 Pin 5m
WC-7641 *was $19.95*
now $14.95 save $5.00

6 Pin to 6 Pin 2m
WC-7644 *was $12.95*
now $7.95 save $5.00

6 Pin to 6 Pin 5m
WC-7645 *was $19.95*
now $14.95 save $5.00

FROM $7.95 SAVE $5

4 Pin to 6 Pin 2m
WC-7647 *was $12.95 now $7.95 save $5.00*

4 Pin to 6 Pin 5m
WC-7648 *was $19.95 now $14.95 save $5.00*

2 Port KVM Switch with HDMI/Mic/Audio Support

Share a stereo speaker, mic, keyboard and mouse across two computers. Connect to a HDMI or DVI input screen. Easily switch between the two at the press of a button. No external power necessary.

- 1 x 3.5mm stereo jack
- 1 x 3.5mm mic jack
- 1 x input cable with 2 x HDMI, 2 x USB and 2 x 3.5mm plugs
- Can support up to 2 x USB2.0 hubs
- Size: 100(L) x 75(W) x 23(D)mm

YN-8094 DUE EARLY JUNE

NEW $119.00

Line Interactive UPS with USB

These robust uninterruptible power supplies strike a good balance between real time system protection and power redundancy where mains electricity is down or unreliable. A steady voltage is delivered during voltage sags and in the event of total power blackout your systems will run long enough to shut down cleanly. Both models feature easy to read LCDs which show battery and load values as a percentage and input/output voltages.

Two models available.

650VA/390W
- Up to 9mins backup on 140W system

MP-5205 $129.00

1500VA/900W
- Up to 49mins backup on 140W system

MP-5207 $299.00

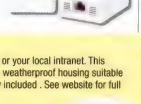
MP-5207

FROM $129.00

Ethernet Over Mains Power

Share Internet throughout your home using your power line. Plug this PLC adaptor into your AC power socket and connect it your modem by a CAT5 cable.

$99.00



- Works up to 300m
- Energy efficient
- Supports up to 500Mbps
- Size: 67.5(L) x 56(W) x 31(H)mm

YN-8352

Pen Style RF Presenter with Laser Pointer

For professionals who frequently use PowerPoint® presentations. You can cycle back and forward through slides, blank the screen, or use the units laser to highlight key points in presentations. Integrated into a pen style unit for easy transportation and usage.

- Compatible with Windows and MAC®
- Sizes: 133(H) x 22(W) x 17(Dia.)mm

XC-5410

NEW $34.95

Wi-Fi Extender - Ceiling Mount

A high-speed solution for broadening coverage and eliminating dead spots in a home or office Wi-Fi setup. Fully compatible with 802.11n protocol. Provides speed up to 300Mbps and functions as an access point and repeater at the same time.

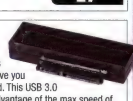
- 5VDC power supply included
- Size: 105(L) x 105(W) x 46(H)mm

YN-8362

NEW $99.00

RS-232 DB9 to USB Converter

Connect a variety of legacy RS-232 devices to your modern computer with this simple adaptor.



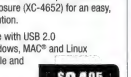
- USB 1.1 compliant
- Speed: Over 250kbps

XC-4927

NEW $27.95

DUE EARLY JUNE

SATA to USB 3.0 Adaptor



A simple way to access files on a SATA hard drive you no longer have installed. This USB 3.0 adaptor will take full advantage of the max speed of SATA (3.0Gbps) for PCs with USB 3.0 port. Combine with the 3.5" HDD enclosure (XC-4652) for an easy, convenient backup solution.

- Backward compatible with USB 2.0
- Compatible with Windows, MAC® and Linux
- Includes USB 3.0 cable and Mains adaptor

XC-4149

$34.95

Also available *3.5" Hard drive case to suit.* XC-4652 $3.95

Hard drive not included

Bullet Mount IP Camera - 720p

Connect this bullet camera to your Ethernet switch and access it via the internet or your local intranet. This professional grade IP camera provides high definition 720p video resolution, in a weatherproof housing suitable for mounting under eaves, with IR LEDs for night time illumination. Power supply included . See website for full specifications.

- 12V, IP66
- Weight: 370g
- Size: 64(Dia.)mm x 145mm

Video Features:
- Compression: H.264 / MJPEG
- Resolution: 1.3M(1280 x 960) / 720p (1280 x 720) / D1(704 x 576) / CIF(352 x 288)

QC-8638

Camera Features:
- Image Sensor : 1/3" 1.3MP Aptina CMOS
- Max. IR LEDs Length: 20m
- Focal Length: 6mm

NEW $279.00

Smartphone Waterproof Case with Windscreen and Bike Mount

Keep your phone secured and protected but accessible while mountain biking, surfing, or for other outdoor activities. It uses a flexible transparent rubber covering while the rear has a clear rear cover for your camera.

- IPX-8 waterproof design
- Suits an iPhone 4S®, iPhone 5® as well as the Samsung Galaxy S3®
- Size: 170(L) x 86(W) x 22(H)mm

HS-9023 iPhone® not included

NEW $49.95

Portable DAB+/FM Radio

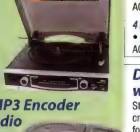
Features a 35mm colour TFT display screen, rechargeable lithium battery and automatic scanning. Up to 60 presets and channel name and radio text all go together to create a great looking and performing device. High quality stereo earpieces included.

- 5 to 90 minute sleep timer
- Size: 113(L) x 69(W) x 25(H)mm

AR-1904

NEW $79.95

Turntable with Speakers & Audio Output



Listen to vinyl collections directly from the unit and its built-in speakers. Features a 3.5mm headphone jack for personal listening with adjustable bass control. It has a line level output for connection to an external amplifier.

$49.00 SAVE $30

- 33/45/78 RPM
- Stereo amplifier
- Automatic stop
- Mains powered
- Size: 350(L) x 310(D) x 130(H)mm

GE-4136 *was $79.00*

CD to USB/SD MP3 Encoder with Clock & Radio

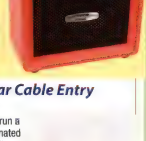
Play and digitally encode your old CD or cassette tape collection straight to SD card or memory stick as MP3 files.

- AM/FM digital tuner with clock function
- Built-in amplifier and stereo speakers
- Requires 2 x AAA batteries
- Size: 250(W) x 204(D) x 85(H)mm

GE-4138 *was $99.00*

$59.00 SAVE $40

Portable Guitar Practice Amp



Feature packed with 32 built-in live rhythm drum patterns, volume, gain, distortion, overdrive and tone controls. AUX-IN jack to connect a CD/MP3 player and jam with your heroes.

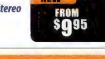
- Built-in E-string tuner
- 2W Mono speaker
- Requires 1 x 9V battery for up to 8 hours play
- Size: 180(L) x 90(W) x 155(H)mm

CS-2553 *was $119.00*

Video Online

$99.00 SAVE $20

Slim 3.5mm Stereo Leads - 2m



Slim design plugs ideal for use with Smartphones, MP3 players, and other small devices where bulky connectors are a hindrance.

Stereo Plug to 3.5mm Stereo Plug Lead
WA-7500 $9.95

Stereo Plug to 2 x RCA Plug Lead
WA-7502 $12.95

Stereo Plug to 2 x 3.5mm Stereo Socket
WA-7504 $9.95

WA-7500

NEW FROM $9.95

Fibre Optic TOSLINK Audio Leads

When a high quality, interference free audio signal is required use TOSLINK fibre optic cables. Suitable for home theatre audio setups.

- Supports Dolby Digital 5.1 surround sound and DTS

500mm	WQ-7293	$7.95
1m	WQ-7294	$9.95
2m	WQ-7295	$14.95
5m	WQ-7297	$24.95

NEW FROM $7.95

HDMI Splitters with 3D and 4Kx2K Support

These HDMI splitters easily share the latest HD movies, TV shows, music videos, internal/external corporate videos from your Blu-Ray player, HD media player or digital set top box across multiple high definition displays. Feature stunning 3D content and support for the recently announced 4Kx2K resolution. Power supplies included.

AC-1700

2 Port
- Size: 63(L) x 54(W) x 18(H)mm

AC-1700 $69.95

4 Port DUE EARLY JUNE
- Size: 154(L) x 69(W) x 23(H)mm

AC-1702 $99.00

NEW FROM $69.95

DisplayPort Wall Plate Socket with 3 Keystone Ports

Standard GPO sized wallplate for creating a neat DisplayPort connection for lecture theatres or meeting rooms.

NEW $14.95

- Higher bandwidth, longer cabling runs

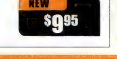
YN-8055

Also available:

DVI Wall Plate Socket with 4 Keystone Ports
YN-8057 $12.95 NEW

VGA Wall Plate Socket with 4 Keystone Ports
YN-8059 $9.95 NEW

Brushed Rear Cable Entry Wall Plate



Allows you to easily run a handful of pre-terminated cables through a wall. Great for use with HDMI, Cat5, component/ composite, S-video, and a variety of other cables.

- Brushed entry
- Concave extrusion

PS-0296

NEW $9.95

IR Remote Control Extender

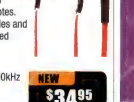
Extend the range of your IR remote control up to 100m. IR commands are sent by the transmitter via 433MHz signal to the receiver in another room, then sent to the components you want to control. Mains plugpacks for transmitter and receiver included.

- Size: 100(Dia.) x 120(H)mm (including antenna)

AR-1817 *was $49.95*

$39.95 SAVE $10

High Performance Stereo Inner Earphones



Ergonomically designed and sits comfortably in your ears producing crystal clear highs and powerful bass notes. Comes with strong flat cables and terminated with a gold plated 3.5mm stereo plug.

- Sensitivity: 105dB
- Frequency range: 20Hz-20kHz

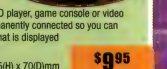
AA-2095

DUE EARLY JUNE

NEW $34.95

Convert, Split & Switch

2 Way AV Selector Switch with S-Video



The unit accepts 2 sets of composite or S-video inputs in addition to stereo audio. Allows a DVD player, game console or video camera to be permanently connected so you can switch between what is displayed on your TV easily.

- Size: 180(W) x 35(H) x 70(D)mm

AC-1651 *was $16.95*

$9.95 SAVE $7

Limited Stock. Not Available Online.

Composite Video / S-Video to Component Converter

Designed to convert standard Composite and S-Video signals from DVD players, set top boxes, gaming consoles etc. to either RGB or YCbCr component video for connection to SDTV or projectors.

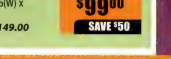
- 5VDC power supply included
- Size: 145(W) x 90(L) x 32(H)mm

AC-1629 *was $149.00*

$99.00 SAVE $50

Limited Stock. Not Available Online.

4 Output HDMI Signal Splitter



Allows one HDMI output device to be distributed to up to four monitors or projectors without any loss of signal.

- Power supply included
- Size: 205(L) x 95(W) x 28(H)mm

AC-1695 *was $149.00*

$99.00 SAVE $50

Limited Stock.

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/06/2013.

60W Soldering Station

Suited to lead-free soldering and is just as capable with ordinary leaded solder. Fitted with a soft insulated rubber grip and has a silicon rubber sheathed power cable. Mains powered.

- Digital LCD display
- Temperature range 160˚C to 480˚C
- Size: 130(L) x 170(W) x 240(H)mm

TS-1390 ***was $179.00***

$149.00

SAVE $30

Note: Spare conical tips available in-store or on-line.

Surface Mount Screw Terminal Strips

HM-3167

Terminate 2 or 3 sets of wires securely with the option of changing or adding connections. Each sturdy block has 2 x 4mm mounting holes at each end and a insulating body with high impact plastic.

NEW

FROM $2.95

2 Way HM-3167 $2.95

3 Way HM-3169 $3.45

PCB Terminal Blocks

HM-3140

These PCB terminal blocks retain the wire securely by a spring type clamp. The wire is held very securely but can be quickly released by depressing a release lever.

2 Way

- Size: 10(L) x 13(W) x 15(H)mm

HM-3140 $2.20

3 Way

- Size: 15(L) x 13(W) x 15(H)mm

HM-3142 $2.90

NEW

FROM $2.20

Electric Screwdriver - 18 bits

Features a comfortable moulded grip, reverse and forward modes, an LED to illuminate hard to see spots, and carry pouch. The drill has three adjustable configurations from the traditional gun style to a cylindrical shape for applying extra pressure on stubborn screws or bolts.

- Mains charger included
- Size: 270(L) x 45(W) x 37(D)mm

TD-2497

NEW

$19.95

Mini Glue Gun

Fast, easy and simple to use with trigger controlled glue feed. Ideal for toys and models, decorations, furniture, woodwork, cardboard, etc. Mains powered and requires 7mm diameter glue sticks (2 supplied).

- 30W
- Mains powered
- Requires 7mm diameter glue sticks (2 supplied)

TH-1997

Also available:

Large Glue Gun TH-1999 $14.95

Note: For intermittent use only. Not for production use.

NEW

$12.95

Easy Coax Cable Stripper

Quickly and easily strip coax cable. Just put the end of the cable in and it will be spring locked in place, then just twist and you will have successfully stripped the end of the cable. There's also an F-type spanner on the opposite side so you can tighten your connections.

- F-type spanner
- Size: 150(L) x 50(W) x 10(D)mm

TH-1813

NEW

$19.95

LED Tester

Check the function, brightness, colour and polarity of all kinds of LEDs.

- Test currents: 1mA, 2.5mA, 5mA, 10mA, 20mA,50mA
- 9V battery required
- Size: 58 x 44 x 25 mm

AA-0274

NEW

$9.95

Heavy Duty Steel Battery Trays

These battery trays are pressed out of 1.2mm mild steel & vinyl coated to protect from acids, oils etc. They feature cruciform slots in the base to facilitate existing mounting holes in a truck or car chassis, as well as slots to allow battery hold-down rods.

HB-8104

Small

- Size: 280(L) x 195(W) x 45(H)mm

HB-8104 $12.95

Large

- Size: 340(L) x 195(W) x 45(H)mm

HB-8106 $13.95

NOTE: Not recommended for marine salt water use

NEW

FROM $12.95

Desk Mount LED Lab Magnifier Lamp

High quality, all metal frame construction magnifier which features 90 super bright LEDs and handle for quick repositioning. A great tool to assist PCB assembly/inspection, jewellers, stamp/coin dealers, etc.

- 120mm, 3 x magnification lens
- 2m long cord
- Mains powered
- Total extended length 900mm

QM-3546

NEW

$119.00

10% OFF Digital Multimeters

- All meters include quality test leads

IP67 True RMS Autoranging Cat IV DMM

Excellent true RMS multimeter that features a large, easily read display and carries an IP67 environmental rating. Features data hold and relative function.

- 4000 count
- Cat IV 600V
- Size: 182(H) 82(W) x 55(D)mm

QM-1549 ***was $79.95***

$71.96

SAVE $7.99

IP67 True RMS Cat IV DMM - 40,000 Count

Get 10% OFF DMMs

Measures up to 1,000 volts AC & DC and is rated to Cat IV 600V. The meter includes temperature and capacitance ranges, as well as peak-hold and min/max options. Includes K-type thermocouple.

- Relative measurement
- Cat IV 600V, 40000 count
- Size: 182(H) x 82(W) x 55(D)mm

QM-1543 ***was $149.00***

$134.10

SAVE $14.90

Autoranging Pocket DMM

- 4000 count
- Data hold

QM-1328

was $29.95

$26.96

SAVE $2.99

Cat III Inductance/ Capacitance DMM

- 2000 count
- Hfe transistor test

QM-1548

was $49.95

$44.96

SAVE $4.99

True RMS Autoranging DMM with Wireless USB

- 4000 count, IP67
- Non-contact voltage
- Wireless USB inteface

QM-1571

was $109.00

$98.10

SAVE $10.90

True RMS Cat IV DMM with Wireless USB & Storage

- 40,000 count, IP67
- Wireless USB interface
- Data log storage

QM-1575

was $179.00

$161.10

SAVE $17.90

IN-CAR ACCESSORIES

In Car DAB+ Receiver with FM Transmitter

Connect this unit to your cigarette lighter socket and then either tune in on the FM band on the car radio or use the supplied 3.5mm audio cable for direct connection. Features radio stabilisation technology to ensure good reception at high speeds as well as a USB socket with adaptors to charge Smartphones and Tablets.

- 35mm (1.44") colour TFT display
- Supports up to 99 preset DAB+ stations
- Antenna cable included
- 12-24VDC input, 5VDC 1.5A output
- Size: 190(L) x 66(W) x 60(D)mm

AR-1902

NEW $119.00

To see if digital radio is available in your area visit digitalradioplus.com.au

Illuminate your Car Exterior

12V LED Spot/Running Lamps

Super bright running lamps produce enough light to run during the day time or used as a spot/flood light fixture. The two piece set produces 120 lumens, improving visibility of vehicles on and off the road.

- 9 White LEDs
- Waterproof, long life and easily installed
- Size: 88(Dia.)mm

SL-3445

$39.95 PAIR

Limited stock.

IP68 Solid Mini LED Spot/Floodlight

Amazingly bright, completely shock and waterproof, and unbelievably compact LED spot/flood lights that are an all-round solution for so many different applications such as reversing lights or side lights on your 4WD. Made from powder coated aluminum alloy casing.

NEW $59.95 EACH

- IP68 rated
- 50,000 hour life
- Instant ON/OFF
- 12 - 24V
- 500 Lumens light output
- Size (mounted): 70(H) x 40(W) x 55(D)mm

SL-3915

Sold individually

IP68 Solid Mini LED Floodlight
SL-3915 $59.95

IP68 Solid Mini LED Spotlight
SL-3916 $59.95

NEW $119.00 EACH

Also available

3500 Lumen IP68 Solid LED Floodlight
SL-3918 $119.00

3500 Lumen IP68 Solid LED Spotlight
SL-3919 $119.00

SL-3918

Replacement Lead to suit Waeco Fridges

Replacement power lead to suit Waeco Fridges. Suits cigarette and merit sockets.

- Length: 1.8m

PP-1982

NEW $19.95

500 Lumens Stainless Steel CREE® Rechargeable LED Torch

Comes with a Li-ion rechargeable battery, mains charger and lanyard.

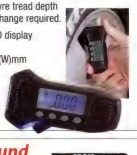
- Burn time: 40mins high / 3hrs low
- Size: 96(L) x 18(Dia.)mm

ST-3488

NEW $59.95

3-in-1 Digital Tyre Gauge

Measures tyre pressure in four units (PSI, Bar, Kgf/cm, Kpa) and tyre tread depth to determine tyre change required.



- Large backlit LCD display
- Pocket-sized
- Size: 100(L) x 50(W)mm

QP-2297

$14.95

In-Car Sound

Response Coax 2 Way Car Speakers

FROM $24.95 PAIR

Ideal replacement for the standard equipment stereo speakers. All are equipped with titanium coated fibre woofers and silk dome tweeters for smooth high frequency response.

- Sold as a pair

4" 15WRMS Speakers
CS-2310 $24.95

5" 17WRMS Speakers
CS-2312 $29.95

6" 22WRMS Speakers
CS-2314 $34.95

6 x 9" 27WRMS Speakers CS-2310
CS-2316 $44.95

Gas Leakage Detector

Gas leaks can be incredibly dangerous, run a quick check over your house with this device holding the power button for a few seconds and then place the detector near the suspected leak and visual/audible warnings will sound if the leak is bad, moderate or safe. Red (Hi), orange (Lo), and green (safe) LEDs denote the severity of the leak.

- Requires 2 x AAA batteries
- Size: 165(L) x 27(W) x 21(D)mm

QP-2299

NEW $39.95

Floating LED Strobe Light Flare

This LED flare is waterproof and will float vertically so the lens end sits above water. An essential safety device for boating enthusiasts!

- Strong magnetic base
- Requires 2 x AAA batteries
- Size: 158(H) x 36(Dia.)mm

ST-3231

NEW $19.95

In-Car FM Transmitter Kit

Play music from your MP3 player, iPhone® or Smartphone through your car stereo with great audio quality. Includes an FM modulator with 4m cable that fits inline with the car antenna for drift-free FM transmission. Supplied with 1m 3.5mm audio cable and charging cable for an iPhone®.

- Power: 12 - 24VDC
- USB output: 5VDC 2A (Enough to charge an iPad®)

AR-3104

$59.95

Remote Control Car MP3 Player

Plugs into car's cigarette lighter socket so you can play MP3 or WMA tracks through the FM tuner in your car stereo. Control it with the front panel, the remote unit or the steering-wheel mounted IR remote.

- 2.5 - 3.5mm stereo cable included
- Supports SD/MMC or USB
- Size: 70(H) x 50(W) x 22(D)mm

AR-1865 *was $34.95*

$19.95 SAVE $15

Limited Stock. Not Available Online.

Self-Adhesive Sound Absorbing Foam

The perfect ultra light weight insulator to use in conjunction with AX-3687 Sound Deadening Material. This durable crush and tear-resistant material has the highest heat blocking properties available in a single layer synthetic foam-type material. Not affected by oil and does not absorb water. It provides acoustic isolation and excellent thermal insulation for roof, firewall, floor, quarter panels, doors and even as an under bonnet liner.

- Size: 660 x 330mm

AX-3662 *was $14.95*

$9.95 SAVE $5

Also Available:

Butyl Based Sound Deadening Material
- Size: 900 x 330mm

AX-3687 *was $29.95 now $19.95 save $10.00*

Combination Butyl/Foam Super Sound Deadener
- Size: 660 x 330mm

AX-3689 *was $29.95 now $19.95 save $10.00*

To order call 1800 022 888

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/06/2013.

POWER ON-THE-GO

Rechargeable CREE® XML Spotlight with Timer

A powerful spotlight that will output up to 550 lumens thanks to the new efficient CREE® XML LED. Features a digital readout and dual swivel handle. Mains and car cigarette lighter plug chargers included.

- 550 lumens
- 2 x LED map reading light
- Size: 285(L) x 166(W) x 197(H)mm (folded)

ST-3314

NEW

$69.95

3A Car Power Adaptor with USB Outlet

Power or charge a wide range of consumer electronics goods such as personal audio players, digital cameras, handheld gaming consoles, mobile phones, PDAs, PSP in the car.

- Input voltage: 12VDC
- Output voltage: 3, 4.5, 5, 6, 7.5, 9.5, 12VDC
- USB output: 5VDC, 1A
- Size: 80(L) x 76.2(W) x 33(D)mm

MP-3671

$29.95

1.8A 6/12V Sealed Lead Acid Battery Charger

This 1.8 Amp charger includes a built in polyswitch for over-current and polarity protection. Includes an LED for power on indication. Supplied with a 2.1mm DC plug and a lead with battery clips.

- 6V or 12V charging
- Short circuit protection
- Reverse polarity protection

MB-3523

$29.95

Note: Will not charge a completely flat battery i.e. 0 volts

150W 12VDC Can-Sized Inverter

25% Off! on selected Pure Sine Wave inverters instore or online

Designed to fit perfectly into your car's drink holder. Ideal for providing mains power without the space or mounting requirements of a full size inverter.

$24.95 SAVE $20

- 12V
- Modified sine wave
- Size: 130(L) x 60(Dia.)mm

MI-5121 *was $44.95*

Limited Stock. Not Available Online.

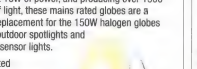
15A IEC C19 Mains Power Lead

NEW

$12.95

- 1.8m

PS-4124



Viribright Outdoor LED Spotlight Globes

Using just 18W of power, and producing over 1300 lumens of light, these mains rated globes are a DIRECT replacement for the 150W halogen globes found in outdoor spotlights and driveway sensor lights.

- IP55 rated
- E27 Edison screw base

1300 Lumens Warm White

SL-2225 $49.95

1500 Lumens Natural White

SL-2227 $49.95

NEW

$49.95 EACH

Ultra-slim LED Caravan Roof Light with Touch Switch

Mount to the roof of a caravan, RV or boat to produce bright white light from its 42 white LEDs. Features a touch switch for lighting control. IP66 rated.

- Voltage: 12-24VDC
- Lumens: 107 lumens
- Size: 130(Dia.) x 11(H)mm

SL-3449

NEW

$39.95

Non-Polarised DC Micro Circuit Breakers (MCBs)

Suits the latest revision of the standards for solar installations that are now in effect (AS/NZS 5033:2012) where over current protection for solar PV arrays must use non-polarised DC circuit breakers. Available in 16A or 20A current rating.

16A 1000VDC SF-4157

20A 1000VDC SF-4159

NEW

$39.95 EACH

Stepdown Transformer

That's 10% OFF!

Quality fully-enclosed stepdown transformer with fold up metal carry handles, approved 3-wire power cord & US style 2 pin 110 - 115V socket.

- 120W 240V - 115V Isolated
- Size: 125(W) x 74(D) x 90(H)mm

MF-1082

MF-1080 *was $99.00*

$89.10 SAVE $9.90

Also available:

250W 240V - 115V Isolated

MF-1082 *was $129.00 now $116.10 save $12.90*

500W 240V - 115V Isolated

MF-1084 *was $229.00 now $206.10 save $22.90*

1000W 240V - 115V Isolated

MF-1086 *was $369.00 now $332.10 save $36.90*

Arduino Corner!

"Eleven" Arduino-Compatible Development Board

An incredibly versatile programmable board for creating projects. Easily programmed using the free Arduino IDE development environment, and can be connected into your project using a variety of analogue and digital inputs and outputs. Accepts expansion shields and can be interfaced with our wide range of sensor, actuator, light, and sound modules.

$39.95

- 8 analogue inputs

XC-4210

Large Dot Matrix Display Panel for Arduino

A huge dot matrix LED panel to connect to your Freetronics Eleven, EtherTen and more! This large, bright 512 LED matrix panel has on-board controller circuitry designed to make it easy to use straight from your board. Clocks, status displays, graphics readouts and all kinds of impressive display projects are ready to create with this display's features.

- 32 x 16 high brightness Red LEDs (512 LEDs total) on a 10mm pitch
- 5V operation
- Size: 320(W) x 160(H) x 14(D)mm

XC-4250 Note: Can for comparison only.

$39.95

Power Kits - No. 1 for Kits

20A 12/24VDC Motor Speed Controller Kit

Refer: Silicon Chip Magazine June 2011

Control the speed of 12 or 24VDC motors from zero to full power, up to 20A. Features optional soft start, adjustable pulse frequency to reduce motor noise, and low battery protection. The speed is set using the onboard trimpot, or by using an external potentiometer (available separately, use RP-3510 $2.25).

- Kit supplied with PCB and all onboard electronic components
- Suitable enclosure UB3 case, **HB-6013** $3.95 sold separately $00
- PCB: 106 x 60mm

KC-5502

$39.95

12V 120W 3-Step MPPT Solar Charge Controller Kit

Refer: Silicon Chip Magazine February 2011

Designed for use with 40W to 120W 12V solar panels and lead acid batteries and provides 3-stage charging with the option of equalisation and with MPPT (Maximum Power Point Tracking). Operation is for 12V panels and batteries. Kit includes PCB, all components and case.

- Charge indicator LEDs
- Temperature compensation for charge voltage
- 3-step charging
- PCB: 111 x 85mm

KC-5500

$129.00

Jaycar Electronics — Better. More Technical.

MID-YEAR SALE

SAVE up to 60% OFF!

Listed below are a number of discontinued (but still good) items that we can no longer afford to hold stock. Please ring your local store to check stock. At these prices we won't be able to transfer from store to store. STOCK IS LIMITED. ACT NOW TO AVOID DISSAPOINTMENT. Sorry NO RAINCHECKS.

Audio & Video Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
AR-1849	AV Sender Experimenters Kit	$249.00	$99.00	$150.00
QC-3685	Balun AV Distribution with Extender Cat5	$199.00	$119.00	$80.00
AC-1608	Converter DVI/Dig Audio to HDMI	$129.00	$89.00	$40.00
GE-4050	Converter Stereo Audio RCA to USB	$49.95	$34.95	$15.00
AA-0498	Docking Station for iPod® with USB and PSU	$119.00	$49.00	$70.00
AA-2060	Earphones Stereo High Quality	$9.95	$5.95	$4.00
AR-1825	IR Over Coax Injector/Receiver	$19.95	$7.95	$12.00
WA-7002	Lead - Audio DIN/SP Plug to 4Plug RCA 1.5m	$8.95	$4.95	$4.00
WA-7083	Lead - Audio RCA 2Plug to 2Plug 10m	$22.50	$16.50	$6.00
WQ-7264	Lead - Audio TOSLINK to 3.5mm Plug 1m	$24.95	$19.95	$5.00
WQ-7244	Lead - AV Scart Plug to 3RCA 1.5m	$34.95	$14.95	$20.00
WQ-7245	Lead - AV Scart Plug to 3RCA RGB 1.5m	$34.95	$14.95	$20.00
WQ-7246	Lead - AV Scart Plug to 3RCA RGB 5m	$59.95	$39.95	$20.00
WQ-7251	Lead - AV Scart Plug to 3RCA RGB 3m	$59.95	$24.95	$35.00
WV-7344	Lead - AV Scart Plug to 6RCA 3m	$19.95	$9.95	$10.00
AC-1663	Speaker Hub 8-Port	$49.95	$24.95	$25.00
AC-1613	Splitter Audio TOSLINK with PSU	$69.95	$59.95	$10.00
CS-2353	Subwoofer 12" VIFA 40hm 250WRMS	$299.00	$179.00	$120.00
CX-2685	Subwoofer Port Adjustable Angled 84mm Dia	$19.95	$9.95	$10.00
XC-0253	Voice Recorder Adaptor for iPod 1,2,3 or 4	$49.95	$3.95	$46.00
LT-3037	Wall Plate Audio/Video Balun Pair	$69.95	$29.95	$40.00
LT-3038	Wall Plate RGB Video Balun Pair	$69.95	$24.95	$45.00
LT-3039	Wall Plate RGB/Dig Audio Balun Pair	$69.95	$29.95	$40.00

Radio Receiver AM/FM/SW with LCD & Clock

AR-1741 was $24.95

$14.95 SAVE $10

Gifts & Gadgets

Cat No.	Product Description	Original RRP	Special Price	SAVE
GH-1330	Coughing Lung Ashtray	$9.95	$7.95	$2.00
XC-0359	Digital Pen for iPhone® and iPad®	$149.00	$129.00	$20.00
GH-1073	Fan with detachable Water Spray	$8.95	$3.95	$5.00
KJ-8954	Kit - Al Dark Line Tracer	$24.95	$17.95	$7.00
KJ-8934	Kit - CSI Detective Science Project	$9.95	$6.95	$3.00
GT-3460	RC Helicopter 3-Ch with iPhone® Control	$79.95	$49.95	$30.00
GT-3430	RC Helicopter 4-Ch 2.4GHz Single Blade	$69.95	$49.95	$20.00
GT-3756	Solar Car Green SUV Racer	$12.95	$7.95	$5.00
GT-3750	Solar Car Mini Racer	$9.95	$7.95	$2.00
AR-1759	Wall Clock with Blue LED Display	$69.95	$39.95	$30.00

Wi-Fi iPhone®/iPad® Controlled Rover

GT-3598 was $169.00

$119.00 SAVE $50

iPad® not included

Security Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
QC-8012	Camera Action Sport Waterproof 1.3MP	$69.95	$59.95	$10.00
QC-3327	Camera Bracket Glass Mount	$19.95	$14.95	$5.00
QC-3467	Camera CCD - B&W Bullet IP57 380TVL Colour	$99.00	$49.00	$50.00
QC-3293	Camera CCD Armour Dome 380TVL Colour	$149.00	$89.00	$60.00
QC-3298	Camera CCD ExView 380TVL Colour	$249.00	$119.00	$130.00
QC-3299	Camera CCD ExView HRes 470TVL Colour	$349.00	$149.00	$200.00
QC-3301	Camera CCD IR-Res 470TVL Sony Colour	$299.00	$129.00	$170.00
QC-3289	Camera CCD Pro Style Wide Dynamic Colour 470TVL	$449.00	$359.00	$90.00
QC-8624	Camera Dome Vandal Proof Colour 2MP	$259.00	$199.00	$60.00
QC-3317	Camera Lens Standard C Mount 2.8mm	$24.95	$19.95	$5.00
QC-3265	CCTV Video/Power Processor 4-Channel	$299.00	$169.00	$130.00
QC-3263	CCTV Video/Power Processor Single Channel	$89.95	$79.95	$10.00
LA-5060	Door Lock Magnetic 12V 180kg	$79.95	$69.95	$10.00
LA-5166	PIR Door Announcer for Children and Pets	$49.95	$19.95	$30.00
LA-5041	PIR Pulse Count Detector 360deg	$169.00	$89.00	$80.00
LA-5123	RFID Keypad Access Controller	$169.00	$79.00	$90.00
ZZ-8954	RFID Tag Clear 21mm Dia	$5.95	$3.95	$2.00
LA-5257	Siren Piezo Flush Mount 12V 108dB	$14.95	$5.95	$9.00

2.4 GHz Baby Monitor System with LCD & Night Vision

QC-3251 was $169.00

$129.00 SAVE $40

Tools, Test & Measurement Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
TD-2176	Bike Tool Set Stainless Steel 6pce	$19.95	$11.95	$8.00
HB-6600	Case Carry for CRO HPS10	$39.95	$19.95	$20.00
WT-3342	DMM Leads with Mini Blade Fuse Fitting	$11.95	$7.95	$4.00
TD-2520	Holesaw Adjustable 63-177mm	$69.95	$36.95	$33.00
TH-1921	Longnose Fishing Pliers Aluminium	$39.95	$29.95	$10.00
QP-2257	Meter Automotive Blade Fuse Current	$99.00	$49.00	$50.00
TD-2088	Screwdriver Set 7-Pce	$8.95	$6.95	$2.00
QP-2289	Tester Coax Cable with Buzzer	$24.95	$17.95	$7.00
TH-1930	Tool Solar PV Connector Assembly	$9.95	$5.95	$4.00

Rechargeable Solar DMM

QM-1546 was $119.00

$69.00 SAVE $50

Power Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
MP-3469	Aircraft Power to Cigarette Lighter Socket Adaptor	$14.95	$7.95	$7.00
MB-3640	Charger Desktop Station	$29.95	$12.95	$17.00
MP-3206	Converter Module DC/DC 18-36V to 5V 600mA	$39.95	$12.95	$27.00
MP-3202	Converter Module DC/DC 24V to 5V 200mA	$21.95	$6.95	$15.00
MP-3200	Converter Module DC/DC 5V to 5VDC 200mA	$19.95	$6.95	$13.00
MP-3204	Converter Module DC/DC 9-18V to 5V 600mA	$32.95	$12.95	$20.00

Occasionally there are discontinued items advertised on a special / lower price in this promotional flyer that has limited to nil stock in certain stores, including Jaycar Authorised Stockist. These stores may not have stock of these items and can not order or transfer stock.

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Fyshwick Ph: (02) 6239 1801

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Bondi Junction Ph: (02) 9369 3899
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Coffs Harbour Ph: (02) 6651 5238
Croydon Ph: (02) 9799 0402
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Rockingham Ph: (08) 9592 9000

Arrival dates of new products in this flyer were confirmed at the time of print but delays sometimes occur. Please ring your local store to check stock details.
Prices valid from 24th May 2013 to 23rd June 2013.

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SERVICEMAN'S LOG

DVD zoning: a long-held pet peeve

Dave Thompson*

A pet peeve of mine over the years has been DVD region or zoning. I thought it had disappeared so you can image my frustration at being caught out with this very problem when I purchased a new home-theatre system.

For those blissfully unaware of zoning, when DVD players were first developed, the powers-that-be decided to carve the globe up into four separate zones: 1, 2, 3 and 4.

As a result, when you buy DVDs, you will usually get disks that have been encoded specifically for sale in your local region or zone. It was done to control distribution but one result is that purchasers in the USA (region 1, of course) often pay half the price that we pay in Oceania (region 4) for exactly the same product.

Now I know what you're thinking; why don't we simply buy region 1 DVDs online and import them. Well, people can and do. Unfortunately though, most manufacturers of DVD players were wise to this possibility and configured their products so they would only play disks from the applicable region.

Admittedly, this system was far more prevalent back when DVDs first started becoming widely available. In my case, I quickly became aware of it because DVD-ROM drives for computers were region-fixed as well. However, in order to allow the same drives to be sold worldwide, DVD-ROM manufacturers typically allowed end-users to play five DVDs, including those from different zones, in a new drive, with the fifth DVD then setting the drive so that its region was the only one playable from that time onwards.

During this process, the relevant zone information was flashed into the firmware of the drive, supposedly never to be changed again.

While various warning dialogs popped up to inform users that this was going to happen, some people were nevertheless caught out. It wasn't at all uncommon for users to end up with drives fixed to a region that was different to most of the commercial DVDs in their possession. As a result, we often had customers come to us, asking if there was a way of changing the region in the hardware once it had been set.

Fortunately, there was but not before a lot of hard work by various people who know far more about DVDs and hardware than I ever will.

There were two main methods available to defeat region information, one software-based and the other a more permanent hardware solution. The software version allows a disc from any region to be played in a region-fixed player by essentially stripping the region protection from the disk on the fly. This meant that the software had to be running in the background in order for it to work.

The problem with this method was that it didn't work with every DVD or optical drive on the market and so was a bit of a hit and miss affair. It was also only useful for watching movies or zoned content on a computer.

A better alternative was to somehow reset the region lock on the DVD drive itself, although this required jiggerypokery that sometimes resulted in "bricked" (read "dead") drives.

I soon discovered that I wasn't alone in railing against this system. Over the years, vast online communities dedicated solely to defeating region protection grew until the manufacturers sat up and took notice of a developing trend. End-users were specifically seeking out and buying the region-free DVD players that were becoming increasingly more available, leaving zoned hardware on store shelves.

Items Covered This Month

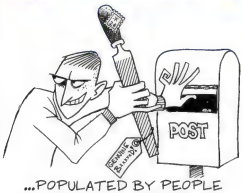
- DVD zoning problems
- Pellet fire ignition fault
- Marconi TF 2155 power supply
- Resurrecting a Tektronix Model 422 oscilloscope

This situation continued until Blu-Ray came along and publishers, manufacturers and distributors found they could once again use zones to control where their products were going and when we were allowed to watch or buy them. I found this out the hard way recently when I purchased a new home-theatre system to replace my aging unit that had suffered in the Christchurch earthquakes.

Over the years I've purchased several stand-alone DVD players to plug into my old home-theatre speaker system and only the very first one was region encoded. It didn't stay that way for long; once I found out the make and model of the optical drive used in it (a Philips unit from memory) I soon located and downloaded some new "hacked" firmware for it.

It was while I was looking for firmware for my zoned drive that I discovered there was region-free firmware written specifically for just about every commercially-available DVD drive. Mind you, all this guerrilla programming and firmware upgrading wasn't totally without risk; there was always a danger that your optical drive was somehow slightly different from the supposedly identical listed model (perhaps a different version of the firmware had been installed) and re-flashing the firmware could ruin the drive.

Obviously, re-flashing voided the warranty so it was all at the user's risk. All things considered though, it was a reasonably safe and widespread practice and I personally didn't lose any drives flashing new firmware. In the end, I helped many hundreds of clients



...POPULATED BY PEOPLE POSTING MALICIOUS FILES

overcome their region problems with this type of fix and it worked just as well on computer DVD drives as it did on home DVD players.

In fact, the optical drives used in commercial DVD players were often identical to those used in computers.

The flashing process couldn't have been easier either. All you had to do was burn the downloaded firmware files to a blank disc, boot the DVD player with the burned disk in it and watch as the firmware was flashed to zone 0 (or "Play All Regions"). You have to love the internet!

Because all my subsequent DVD players were purchased region-free off-the-shelf, as were the optical drives used for client's computers, flashing firmware soon became a relic of the past. In fact, region-free players became so common that many of those once-thriving online communities dwindled and faded from view.

And then, just recently, I bought my shiny, new LG Blu-Ray home-theatre system . . .

A rude shock

Initially, I was very impressed with it. It plays music and movie files in just about any format from multiple sources, such as over a home intranet, from the internet, from a disc or from any USB-connected device such as a flash drive or an external hard disk. No more burning files to a DVD before being able to view them.

One night, a week or so after we set it up, we decided to watch one of our older DVDs which we'd purchased overseas. However, when I inserted the disc in the player, it was immediately ejected with a "Check region" message on the screen. I was quite stunned by this and immediately thought that there had to be some kind of mistake.

I tried again and the same thing happened. I then discovered that this unit wouldn't play anything but region 4 discs, leaving me disappointed and angry. If I could have returned the system on that basis, I would have (and perhaps could have but I wasn't sure how far my consumer rights went in this situation). I'd thought we were done and dusted with this region hassle a long time ago but here I'd walked straight into it like a complete bunny.

In my opinion, the fact that it was a zoned system should have been made patently clear on any sales bumf. However, a subsequent visit to the store we purchased it from revealed that there was no indication that any of the home-theatre units sold there were zoned, even though, as we soon discovered, they all were.

After eventually cooling down, I thought no matter, I'd simply find some new firmware online and flash it like I'd done a hundred times before. But I quickly struck a dead-end; nobody has yet managed to reverse engineer our model's firmware (nor many others it turns out), meaning that there is no firmware available to make our player region free. And so, after days of fruitless internet searching, posting in forums and even writing to a couple of Australian companies specialising in de-zoning Blu-Ray players, it eventually became apparent that there was no way we were going to circumvent our zoning problem – at least not, any time soon.

I also discovered that those previously helpful online forums with their vast knowledge-bases and resources had become wastelands, populated by people posting malicious files, misinformation, hearsay and outright fabrications. I don't know why people feel the need to post meaningless and useless information; it dilutes the value of such forums and wastes time.

An example is one forum where someone asked the same question I was asking, ie, how to make my specific model of LG Blu-Ray player region free. Unfortunately, people were responding with instructions that had absolutely no relevance to our model of Blu-Ray player. For example, some were suggesting that various buttons should be pushed in a certain sequence when those buttons don't even exist on the model in question.

Yet others claimed they'd gotten their players working but the information they supplied was either so vague as to be useless or very obviously false. Out of sheer desperation I did download a file that I'd seen referred to in many forum posts which was supposed to be able to set any LG DVD player to region-free. I gave it a shot; as before I burned the firmware files to a blank disk then put the disk in and waited for it to auto-run and for a menu to appear. However, in our case, we got no menu – just a disc we could browse but not play or run files from.

I must confess that I didn't really think it would work but it was worth a try. In fact, this file might very well work on any LG-branded DVD player but ours is a Blu-Ray player and that makes all the difference.

With that attempt behind me, I then opened the unit to eyeball the optical drive but it turned out to be a proprietary unit. It was unlike any I'd seen before, with no discernible model numbers or any other visible information. So unless someone creates new firmware or finds another way around it, our player is always going to be zone 4 only.

I have to admit that I'm still rather steamed about it. Most of our DVDs have been purchased overseas, either by buying them online or purchased while on holiday. Given that many of these titles were never released in our part of the world anyway, how else are we supposed to get hold of them?

We've even bought plenty of Zone 1 and Zone 2 DVDs in NZ at the larger

Servicing Stories Wanted

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Please be sure to include your full name and address details.

DVD stores but of course none of these discs will play on our fancy new system. If I'd known that, I wouldn't have bought it and I feel like a fool because I didn't ask if it was region-free at the time.

In my defence, I thought the days had long gone where "region free" was a selling point. Well, I know better now and if regions matter to you then be careful if buying a modern system because you could find yourself in the same position.

Pellet fire

It gets very cold here in Christchurch but many houses (including ours) were built decades ago and don't have insulation. After all, people were hardy souls back then and what's more, there was plenty of coal and wood to burn in open fires.

Unfortunately, that created serious smog problems and so open fires and older wood burners were eventually banned, replaced by heat pumps, clean-air approved log burners and various forms of electric heating. We ditched our log burner years ago due to the increasing cost and hassle of firewood. However, because we like the mood created by flickering flames, we opted for what in New Zealand is called a pellet fire or pellet stove.

Pellet fires burn pellets made of compressed sawdust and are amazingly efficient, stoking out up to 12kW of heat with very little emissions or electricity used. Operation is simple; the top half of the stove holds the pellets and these are fed by an electrically-driven auger from the hopper into a small rectangular burn pot which sits inside a fireproof chamber. This burn pot is a metal box about the size of a block of butter and has a series of holes bored in it to assist with air flow.

As pellets drop into it, air flowing through the burn chamber feeds the fire that consumes the pellets and when the fire is up to temperature, the heat produced is propelled out into the room by a fan blowing the air over radiator heat-exchanger tubes.

The more pellets you put into the burn pot, the hotter the fire burns, so slowing down the pellet feed turns the heat down. It is a very clever and efficient system but it does have drawbacks. First, you still need a flue, even though there is virtually no smoke or emissions due to the complete consumption of the pellets. Second, a small amount of ash is produced, usually due to impurities in the fuel. And third, pellet fires still need power to run everything and while in a pinch you could run it from a car battery, if the power gives out (as it does during, say, an earthquake), then the fire eventually burns out and the house gets cold.

One major design flaw our fire has is the ignition system. Getting it going isn't difficult; all you need is pellets falling into the burn pot, air rushing through the burn chamber and a heat source to ignite it, all usually accomplished with one button push. Basically, a 240V resistive, element-style igniter unit sits pointing into the burn pot and its tip glows red hot when the button is pushed. Then, when pellets fall nearby, air blowing through the burn pot creates embers and then a flame.

At this point, the igniter becomes redundant but it isn't switched off and stays on (and glowing) as long as the fire is running. That's probably why we've gone through three igniter units during the last five years. What's more, at nearly $200 a pop, replacements aren't cheap.

~ALL I HAD TO DO WAS BURN THE DOWNLOADED FIRMWARE FILES...

Being a serviceman, I figured that there just had to be a better way of doing it, or perhaps a way of refurbishing a dead igniter using NiChrome wire or similar. However, after much experimentation and research I've been unable to make (or even find any information on making) a suitable replacement. I've also shied away from breaking into the on-board electronics to use one of the many thermostat circuits to turn the igniter off lest I make more of a mess.

No matter; a splash of methylated spirits on a handful of pellets in the burn pot and a BBQ lighter is a working "low-tech" solution and I'll stick with that until I find a better way of doing it. Maybe someone has an idea?

Marconi DC power supply

This next story comes from L. W. of Rochedale South, Qld who recently tackled a fault in an old Marconi TF 2155 DC Power Supply. Here's what happened . . .

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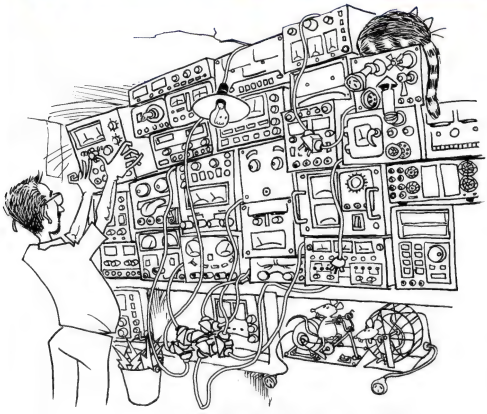


~AS THE SAYING GOES, YOU CANNOT HAVE TOO MANY BENCH SUPPLIES

ply has a fixed 5V output and three variable voltage ranges from 0-60V. The lower ranges are rated at 2A, the mid-range at 1A and the 60V range at 0.5A. In addition, the voltage ranges are all current limited and the front-panel analog meter can be switched to read either voltage or current.

My unit was acquired about 12 years ago in non-working order and just recently I decided to see if it could be repaired. After removing the cover, it was obvious that someone had attempted to repair the unit before me as several of the transistors had been replaced and the wiring to the main filter capacitor had been disconnected. I was lucky enough to have the instruction manual which included operating instructions, a technical description and most importantly, the circuit diagrams.

The first thing I noticed is that the mains lead is attached to the PCB and the copper track leading away from a pad in the upper corner of the board was exposed. As a result, I decided to do as much fault finding as possible with the unit in a non-powered state.

There seemed to be a mixture of "new" and "old" resistors on the board although I couldn't imagine that somebody had replaced over half the old resistors with new ones. The power supply appears to have been built in the early to mid-1970s (the manual was printed in July 1974), so I thought it unlikely that so many of the original resistors would have gone faulty.

Nevertheless I checked each resistor and compared its value to the parts list. Those that could not be checked in-circuit had one lead lifted to determine their value, a time-consuming but necessary process.

Next I tested all the semiconductors. All the diodes came up OK but as I progressed through the 19 odd transistors, I discovered that transistor VT4 was faulty. The parts list specified an MPSA06 but I found a 2N4401 in its place. In the end, I chose a BC337 as the replacement and carefully fitted it in circuit.

All the other transistors checked out OK but there was more to come on that front.

Next, I turned my attention to the electrolytic capacitors and these all tested OK as did the pushbuttons for selecting the various voltage ranges and the function of the panel meter. At that point, it was tempting to re-assemble the unit to a stage where I could apply power and check out its operation. However, before doing that, I decided to mark the transistor leads so I would be able to easily identify them should it prove necessary to take voltage measurements. I didn't fancy blindly poking around with all that unprotected copper operating at mains potential!

So, starting at VT1, I began marking the copper side of the PCB to identify each lead. This went OK until I got to VT3 and discovered that both it and VT5 had been replaced with BD140s. Whoever had done this had also made a note next to the parts list stating that this replacement was not ideal but was the best available.

I then discovered that while VT3 was orientated correctly, VT5 had been fitted incorrectly. I removed it, checked it again just to be sure and refitted it, this time the correct way, although this did require some lead bending.

After labelling the rest of the transistors, I then reassembled the unit, plugged it into my mains isolation transformer, connected a voltmeter across the output terminals and, with much trepidation, switched it on. It seemed to pass the smoke test so I attempted to adjust the output and all worked as it should. I then checked the other voltage ranges and they could also be varied correctly.

Next, I connected a load and checked the current limiting on all the ranges. And again, everything worked as it should. However, I did adjust the panel meter calibration to match the readout on my digital multimeter.

I now have a "new" bench power supply to add to my existing range of home-built units. As the saying goes, you cannot have too many bench supplies.

Tektronix oscilloscope

Restoring a 50-year-old scope to full working order requires both knowledge and initiative. J. G. of Carlton North, Victoria recently brought a Tektronix Model 422 back to life . . .

Tektronix oscilloscopes are often seen as the "Rolls Royce" of instruments and many older cathode ray

tube (CRT) analog models are still regarded with affection. In the words of one collector: "I collect them not because they are useful to me. I collect them because they are interesting, inspiring, beautiful and challenging to understand completely".

I recently bought a model 422 on ebay for $70, described as "for parts only", with the idea that it would be an interesting challenge to bring it back to life. The 422 is a compact portable model that dates from the mid 1960s. It is largely solid-state but has three Nuvistors, the last gasp of valve technology, and several gas-filled high-voltage regulator tubes which will only be remembered by the older generation such as myself.

When I turned on the power, there was no sign of life. I soon discovered that the fuse had blown which isn't a good sign as it usually indicates a fault. When I replaced it, it immediately blew again so this was going to take some work.

When a fuse blows, the first place to look for the fault is the power supply. This particular model has a sophisticated high-frequency AC-DC power supply, detachable from the rear via a 24-pin connector and a long cable, thereby allowing easy access to the interior.

The internet has made a huge difference when it comes to repairing such equipment. A Google search quickly located Stan Griffiths, who had worked with Tektronix for many years and had repaired thousands of their instruments. He was a tremendous help. He has written a book "Oscilloscopes: Selecting and Restoring a Classic", which is out of print but available in digital form on the web.

Another book, "Troubleshooting Your Oscilloscope" by Tektronix, is also available on the web. In addition, I was able to download the excellent user manual for the 422, complete with circuit diagrams, detailed explanations and troubleshooting guides. The most helpful item was a table of the expected resistance to earth of all 24 pins on the power supply connector. This allowed me to narrow the fault down to a shorted electrolytic capacitor on the -12V rail.

The electro had also taken a fast rectifier diode with it so I replaced this diode and its full-wave partner, installed a low-ESR replacement electro and checked all the other electros.

On powering up, I was greeted with a high pitched whistle, indicating that the high-frequency power supply was now functioning. The indicator lights also lit up on the front panel but there was no sign of a trace.

The next step was to measure all the power supply outputs: +95V, +55V, +12V, -12V and -1420V. All were within reasonable limits.

What about the CRT circuits? The EHT was just under 5000V and the voltages on the cathode, grid and focussing electrodes were all were close to the correct values. In addition, the filament was intact and the filament voltage was also correct.

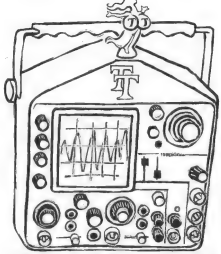
At this point, Stan Griffiths told me that a likely cause of "no trace" would be that the beam is present but deflected off to one side. One of the nice things about Tektronix scopes is that it is easy to disconnect individual circuits. Upon disconnecting the X and Y deflection plates, I was rewarded by the appearance of a spot near the middle of the screen, indicating that the tube was OK. I was getting somewhere.

The next step was to reconnect the X and Y deflection plates and disconnect the inputs to the X and Y amplifiers (the timebase and the vertical preamplifiers, respectively). The spot remained near the centre of the screen, suggesting that the outputs of the X and Y amplifiers were now balanced.

When I subsequently reconnected the timebase circuit, there was a horizontal line on the screen, indicating that the X amplifier and timebase circuits were OK. That meant that the fault had to be in the vertical system. A quick check confirmed that the voltages on the Y plates were seriously unequal. No matter which Y preamp was connected, the voltage across the Y plates was unbalanced, causing the line to disappear.

So either both Y preamps had a fault or there was a fault that affected them both. It was then that I discovered a locally regulated -20V source which measured just -10V. It was a clue but was this voltage low because of a fault in the supply or because it was excessively loaded?

Disconnecting the Y preamp boards in turn revealed that Channel 2 was loading down the -20V line. When I disconnected the Channel 2 board, the -20V rail shot up to its correct value and the Channel 1 line reappeared on the screen. It was then relatively



TEKTRONIX OSCILLOSCOPES ARE OFTEN SEEN AS THE "ROLLS ROYCE" OF INSTRUMENTS

simple to locate a short to earth in Channel 2, close to the Nuvistor tube socket. It was caused by two bare wires touching each other.

How this happened is a mystery but when I removed the short, the problem disappeared. So a fault in one vertical preamp had affected them both.

Incidentally, the Nuvistors in the 422's vertical preamplifiers act as simple cathode followers and sources on the internet indicate that they can be replaced pin-for-pin with MPF102 JFETs (ie, no other changes). Indeed, later versions of the 422 actually replaced the Nuvistors with JFETs.

Two problems remained. First, the trace was rather dim, even when the brightness was fully turned. Fortunately, I had already bought a "brand new" Tektronix tube in its original 1965 carton ($40 on eBay). Installing this in place of the original tube fixed that problem and gave a nice, bright trace.

The final problem was minor – one graticule lamp had burnt out and the other was dim. I couldn't find replacements for the tiny 12V "slide in" globes, so I replaced them with ultra-bright yellow LEDs and 330Ω series resistors. Problem solved.

All that was left was to make a slight adjustment to the automatic triggering threshold. I now had a fully functioning scope but it was sobering to think that I can now buy a far more sophisticated digital instrument for less than $400. It would be a quarter the size, a tenth the weight and have four times the bandwidth of my old Tektronix 422. But I had at least $110 worth of fun. SC

A versatile 10-Channel Remote Control Receiver

Works with a universal IR remote, either directly or via a UHF radio link

This 10-channel control system can be used with any universal IR remote control and can even be controlled via a UHF link so you don't have to worry about range or high light levels affecting infrared operation. It can be used to switch relays (and other devices) on and off, making it ideal for controlling motors, lights, solenoids, door catches and robots, etc.

LET'S CLEAR UP some confusion right at the start. Most infrared remote controls are intended to control various functions on just one appliance. For example, your TV remote enables you to control all its functions: channel change, volume, mute, picture and so on. By contrast, this 10-Channel Remote Control enables you to use a single infrared remote control to control up to 10 separate devices, turning them on or off. Or you could use it to control more functions on less devices but still using up to 10 buttons on your universal remote.

Each channel in the receiver unit has an open-collector output which can drive an external relay, drive one or more LEDs or even directly switch low-power 12V equipment. Each output is initially set as momentary, meaning that the output is only active while you press the relevant button on the remote control.

Alternatively, one or more of the outputs can be set to change state (toggle) when you press the relevant button on the remote (ie, each output can be set independently). That means that an output that was previously ON turns OFF (and stays OFF) when its channel button is pressed, while an output that was previously OFF turns ON when its button is pressed.

Each individual toggle output can also be set up to be either ON or OFF when power is applied to the unit. For example, you can set the unit to switch on with Channel 1 OFF, Channel 2 ON, Channel 3 ON and so on. By contrast, the momentary outputs are always all off at power up and their initial switch-on state cannot be altered.

An Acknowledge LED indicates whenever a valid remote control signal is received.

Presentation

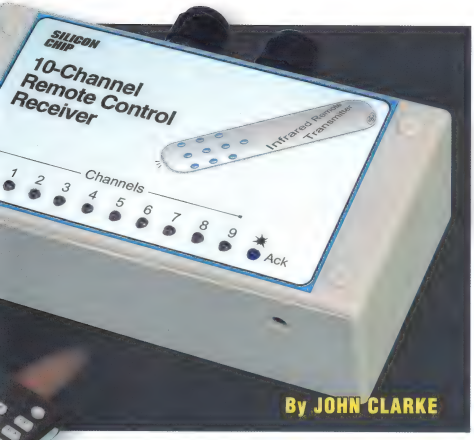
The 10-Channel Remote Control Receiver comprises a small box that includes 10 LEDs to indicate the state of each channel. These are labelled from 0-9, corresponding to the 0-9 buttons on the remote control. Each channel has an output that is capable of sinking up to 500mA, so it is suitable for driving a 12V relay or similar load, as indicated above.

Power for the unit comes from a 12V DC plugpack supply. The current requirements depend on what sort of load each channel drives. For 12V relays, you could need up to 75mA for each relay but the overall current requirements depend on whether the outputs are set for momentary or toggle operation.

If momentary operation for all outputs is selected, there will be only one relay on at one time and so a minimum of 85mA is required for the supply, ie, 75mA for the relay and about 10mA for the circuitry. For toggle operation on all outputs, all relays could be switched on at the same time and up to 750mA or so would be needed from the 12V plugpack.

The infrared (IR) remote control needs to be a universal type that can be programmed to operate Philips brand or similar appliances. The 10-Channel Remote Control Receiver can operate

Most universal remote controls can be used with the unit, including the Altronics A1012 (pictured) and the Jaycar AR1726.



using the code for either a TV, a CD player or one or two satellite receivers. Alternative choices are given so that when using the remote to operate the 10-Channel Remote Control Receiver, it does not affect any other appliances you may have.

For example, you may find that when the 10-Channel Remote Control Receiver is set to operate using the TV code, your TV also responds. In that case, it's simply a matter of using one of the alternative codes (ie, for a CD player or satellite receiver).

UHF radio link

As well as making provision for IR reception, the 10-Channel Remote Control Receiver can alternatively use a 433MHz UHF receiver module. This means that it can be controlled from an IR remote via a UHF radio link – necessary if you don't have line-of-sight for infrared signals.

For this reason, we're also publishing the circuit details for an "IR To UHF Transceiver" (see the following article). Push a button on your IR remote and the coded IR signal is picked up by this transceiver, converted to a 433MHz radio signal and transmitted to the 10-Channel Remote Control Receiver. Provided you have line-of-sight between the remote and the transceiver, you're in business – the UHF radio link does the rest.

How it works

Refer now to Fig.1 for the circuit of the 10-Channel Remote Control Receiver. It's based on either an infrared receiver (IRD1) or a 433MHz receiver module (RX1), a PIC16F88 microcontroller (IC1) and a couple of ULN2003 Darlington arrays (IC2 & IC3). The micro decodes the remote control signal codes and drives the channel outputs accordingly.

The IR receiver module (IRD1) comprises an IR detector, an amplifier and a demodulator. The demodulator removes the 38kHz infrared modulation of the transmitted signal and the output at pin 1 then comprises the on and off levels that constitute the IR encoding. With no signal, the output remains high at about 5V.

The alternative UHF receiver (RX1) receives the UHF signal from the IR To UHF Transceiver and outputs the encoded signal at its Data terminal. This signal is inverted compared to IRD1's output and so the SET jumper at pin 8 of IC1 is provided to allow either receiver to be selected. When open, the SET input is pulled high (ie, to 5V) via a pull-up resistor inside IC1 and this selects IR signal decoding.

Alternatively, when the SET jumper is installed, pin 8 of IC1 is pulled low (0V) and this instructs IC1 to decode a UHF signal.

Note that for UHF reception, RX1 is installed but IRD1 must be left off the PCB. Alternatively, for IR reception, you would normally just have IRD1 installed. However, in the latter case, you can actually also mount the UHF receiver on the PCB. That's because RX1's output is a high impedance and so would have negligible affect on IRD1's output.

Code links

The Code 1 and Code 2 jumpers,

Features & Specifications

Main Features

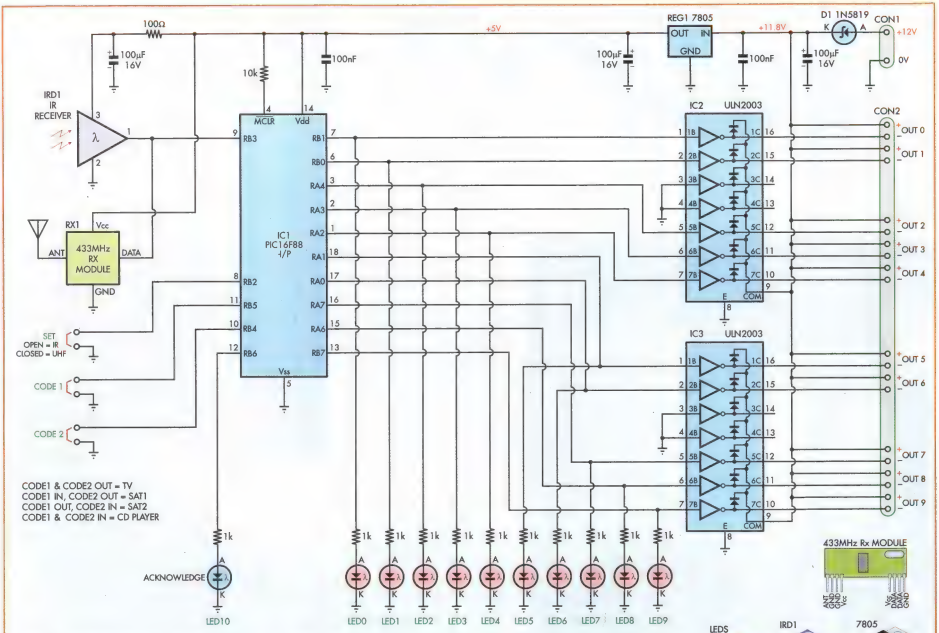
- Uses a commercial infrared hand-held transmitter
- 10 independent channels
- Momentary or toggle operation
- Selectable output state on power up for toggle selection
- 500mA open collector sinking outputs for each channel
- Outputs suitable to directly drive 12V relays
- Infrared or UHF (433MHz) reception
- Acknowledge LED flashes while receiving transmission

Specifications

Power supply requirements..... 12V at up to 50mA plus current drawn by each output; up to 760mA required for 10 relays if all powered at once

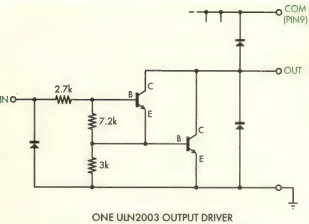
Infrared range.....10m line-of-sight

UHF range.....30m in open space



SC 10-CHANNEL REMOTE CONTROL RECEIVER

Fig.1: the circuit uses either an IR receiver (IRD1) or a 433MHz receiver module (RX1) to pick up the remote control signals. These signals are processed by microcontroller IC1 (PIC16F88-I/P) which then drives two ULN2003 Darlington arrays (IC2 & IC3) plus the Acknowledge and channel indicator LEDs.



ONE ULN2003 OUTPUT DRIVER

Fig.2: the internal Darlington transistor arrangement for the ULN2003 ICs. There are seven such output driver stages inside each device.

on pins 10 & 11 of IC1 respectively, select the encoding mode, ie, either TV, satellite (SAT1 or SAT2) or CD player. Both the circuit and Table 3 towards the end of the article show the jumper linking options to select each code (eg, leave both jumpers out to select TV encoding).

IC1's RB6 output at pin 12 drives the Acknowledge LED (LED 10). This lights whenever a valid remote control signal, either IR or UHF, is being received.

IC1 decodes the remote control signals and provides the 10 channel output signals to drive the Darlington arrays (IC2 & IC3). For example, the channel 0 signal is at RB1 (pin 7) and this drives pin 1 of IC2. Similarly, the channel 1 signal appears at the RB0 output and this drives pin 2 of IC3, and so on for the remaining eight outputs. Note that output channels 0-4 drive IC2, while outputs 5-9 drive IC3.

IC2 & IC3 each include seven separate Darlington transistors, with five Darlingtons used in each package to make up the 10 channels. Fig.2 shows the internal Darlington transistor arrangement for each driver.

As can be seen, the first NPN transistor is driven via a 2.7kΩ resistor, while its emitter drives the second NPN transistor's base. The collectors are commoned to provide an output that can sink up to 500mA when the input is driven by 5V (ie, a Darlington arrangement).

In addition, a diode clamp is connected between each output and the common pin of the IC. This ensures that the transistors are protected from over-voltage when driving an inductive load.

The common pin for the diodes connects to the 11.8V supply. This 11.8V supply is also connected to each of the channel outputs on CON2 (a 20-way screw-terminal block), to provide the positive output terminals. The collector outputs from the Darlington arrays connect to the negative terminals, so that they sink the load current when active.

That way, a relay coil can be directly connected to each pair of output terminals, ie, between the +11.8V supply and the individual collector outputs.

5V regulator

Power for the circuit is derived from an external 12V supply (eg, a plugpack), with Schottky diode D1 providing reverse polarity protection. The resulting 11.8V rail is then filtered using 100µF and 100nF capacitors and fed to 3-terminal regulator REG1. REG1 then provides a 5V supply rail for IC1, IRD1 and RX1 (the 433MHz receiver module).

Note that the supply rail for IRD1 is decoupled via a 100Ω resistor and 100µF capacitor. This minimises supply variations and glitches from being decoded as control signals.

In addition, the 11.8V rail at the output of D1 is fed to the positive terminals of CON2, as described above.

RC5 codes

The Philips RC5 code for infrared transmission is used by many manufacturers including Philips, Marantz, Mission, Grundig and Loewe. The code comprises two start bits and one toggle bit that alternates between high and low on successive same key presses. A five bit address is then sent, followed by six command bits.

The bits are sent using bi-phase encoding, whereby a high-to-low transition represents a low bit and a low-to-high transition a high bit. The data is transmitted at a 1.778ms rate, with the whole code taking at 24.889ms to send. The next code starts after 113.778ms.

As stated above, the RC5 remote control signal, either from IRD1 or RX1, is decoded by IC1.

Building it

Take a look now at Fig.3 for the assembly details of the 10-Channel Remote Control Receiver. It's built on a PCB coded 15106131 (123 x 61mm) and this clips neatly into a plastic utility case measuring 130 x 68 x 44mm.

Install the resistors and diode D1 first. Table 1 shows the resistor colour

Parts List

1 PCB, code 15106131, 123 x 61mm
1 UB3 box, 130 x 68 x 44mm
1 panel label, 102 x 61mm
11 2-way PCB-mount screw terminals, 5.04mm pitch
1 DIP18 IC socket
1 M3 x 10mm screw
1 M3 nut
3 2-way pin headers with 2.54mm pin spacing
3 pin header jumper shunts
1 170mm length of hook-up wire (UHF version only)
1 2.1mm bulkhead-mount DC socket

Semiconductors
1 PIC16F88-I/P microcontroller programmed with 1510613A.hex (IC1)
2 ULN2003 Darlington arrays (IC2,IC3)
1 infrared receiver (TOSOP4136 or similar) (IRD1) or 1 433MHz receiver (Jaycar ZW-3102, Altronics Z 6905A) (RX1)
1 7805 5V regulator (REG1)
1 1N5819 1A Schottky diode (D1)
10 3mm red high-brightness LEDs (LED0-LED9)
1 3mm blue high-brightness LED (LED10)

Capacitors
3 100µF 16V PC electrolytic
2 100nF MKT polyester

Resistors (0.25W, 1%)
1 10kΩ 1 100Ω
11 1kΩ

Miscellaneous
Cable glands, hook-up wire

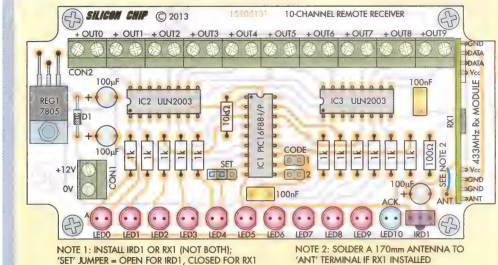
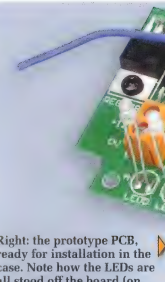


Fig.3: follow this layout diagram to install the parts on the PCB. Note that either IRD1 or RX1 is installed but not both (see text). You will need to solder a 170mm-long antenna to the 'ANT' terminal if RX1 (the UHF module) is used.



Right: the prototype PCB, ready for installation in the case. Note how the LEDs are all stood off the board (on 25mm lead lengths) so that they later protrude through the holes in the case lid.

codes but you should also check each one using a digital multimeter before soldering it into place. Make sure the diode is installed with the correct polarity, with the banded end orientated as shown on the layout diagram.

Once these parts are in, REG1 can be fitted. It's mounted horizontally on the PCB, with its leads bent down through 90° so that they go through their respective holes. Secure its metal tab to the PCB using an M3 x 10mm machine screw and nut before soldering its leads (note: don't solder the leads first, otherwise the PCB tracks could fracture as the nut is tightened).

Follow with the three 2-way pin headers for the SET, Code 1 & Code 2 jumpers, then install an 18-pin IC socket for IC1 (be sure to position the notched end as shown). You can also install sockets for IC2 & IC3 if you wish but these are optional. If you don't wish to use sockets, these two devices can now be directly soldered to the PCB, with their notched ends facing towards REG1.

Do not insert IC1 into its socket yet – that step comes later, after you've checked the 5V supply rail.

The capacitors are next on the list. The two 100nF capacitors can go in either way around but be sure to install the three 100µF electrolytics with the correct polarity.

The 20-way screw terminal block (CON2) can now be installed. It's made up by dovetailing 10 2-way blocks together and must be fitted with the wire entry holes facing outwards. Push it all the way down so that it sits flush against the PCB before soldering the terminals. Once it's in, the 2-way terminal block (CON1) can be fitted at lower left.

Installing the LEDs

Now for the LEDs. These must be installed so that the top of each LED is exactly 30mm above the PCB surface, which means mounting them with 25mm lead lengths.

The easiest way to do this is to use a 25mm wide strip of cardboard as a spacer. It's just a matter of pushing each LED down onto this strip (ie, leads on either side) before soldering it to the PCB. Be sure to orientate each LED correctly, with the longer anode leads to the left.

Our prototype used red LEDs for LEDs0-9 and a blue LED for LED10 (Acknowledge) but any colour can be used.

IR/UHF receiver module

The PCB assembly can now be completed by installing either the infrared receiver (IRD1) or the UHF receiver (RX1) and configuring the SET jumper.

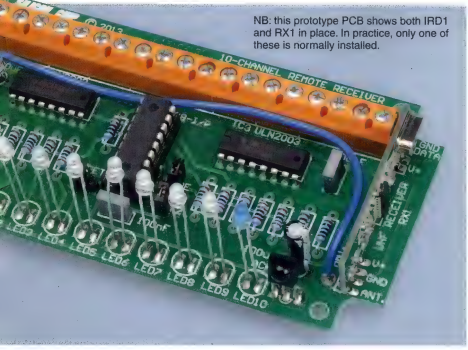
Install IRD1 and leave the SET jumper out if you want to use infrared signals to control the 10-channel receiver. It goes in with its lens facing the adjacent edge of the PCB and is installed with its leads left at full length so it can later be pushed into position to align with its case hole.

Alternatively, install RX1 and fit the SET jumper if you want to control the receiver using a 433MHz UHF radio link. RX1 must be orientated with its component side to the right. **In addition, a 170mm-length of hook-up wire must be soldered to the antenna (ANT) terminal to pick up the 433MHz signal.**

Don't also install IRD1 if you intend using the 433MHz transceiver (RX1), as this would upset the latter's opera-

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	11	1kΩ	brown black red brown	brown black black brown brown
❑	1	100Ω	brown black brown brown	brown black black black brown



NB: this prototype PCB shows both IRD1 and RX1 in place. In practice, only one of these is normally installed.

tion. Conversely, you can fit both IRD1 and RX1 if you intend using IRD1 to pick up the remote control codes, as explained previously. You might want to do that if you intend swapping over and using RX1 at some later date (in which case you would then have to remove IRD1).

Final assembly

Before installing the PCB in the case, you will need to drill holes in the rear of the base for the DC power socket, plus holes to accept two cable glands. The cable glands route and secure the various leads from the output terminals on CON2.

The DC socket hole should be drilled in one end of the case, ie, near CON1 on the PCB. It should be centred horizontally and positioned about 12mm down from the top of the base. Use a small pilot drill to drill this hole first, then carefully enlarge it to size with a tapered reamer until the socket is a neat fit.

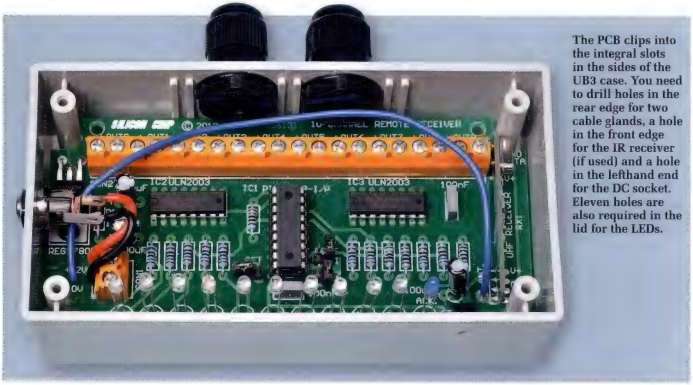
The two cable gland hole centres are exactly 14mm down from the top of the base and must be centred between the two sets of vertical rib pairs. Drill these holes using a pilot drill initially, then enlarge them to 12mm using a tapered reamer.

In addition, a 4mm hole must be drilled in the front of the base in-line with IRD1's lens. This hole is position 22mm in from the adjacent side (as measured at the top of the base) and 11mm down.

A row of 11 3mm holes is also required along one edge of the lid to accept the LEDs. These holes can be drilled using the front panel artwork as a template. This artwork can be downloaded from the SILICON CHIP website at **www.siliconchip.com.au** (select "Shop" and then "Panel artwork") and temporarily attached to the lid using tape.

After drilling, clean up the holes using an oversize drill, then print out another copy of the artwork onto photo paper and attach it to the lid using silicone sealant (or some other suitable adhesive). Once the silicone has cured, the holes for the LEDs can either be punched out or cut out using a sharp hobby knife.

The assembly can now be completed by clipping the PCB into place, fitting the cable glands and the DC socket and running the positive and negative supply leads between the DC socket



The PCB clips into the integral slots in the sides of the UB3 case. You need to drill holes in the rear edge for two cable glands, a hole in the front edge for the IR receiver (if used) and a hole in the lefthand end for the DC socket. Eleven holes are also required in the lid for the LEDs.

Table 1: Link Selections For Infrared Device

Link	TV	SAT1	SAT2	CD Player
CODE1	Out	In	Out	In
CODE2	Out	Out	In	In

The remote control coding will have to be set up before the unit is used. This involves installing the Code links on the PCB (see Table 1) and setting up the remote to suit (see text).

This close-up view shows how the DC socket is wired to screw-terminal block CON1.

and CON1. **It's also necessary to bend IRD1's leads so that its lens is aligned with its hole in the side of the case.**

Initial checks

Now for the smoke test. Check the assembly carefully, then connect a 12V DC plugpack, switch on and measure the voltage between pins 5 & 14 of IC1's socket. You should get a reading of between 4.85V and 5.15V. If this is incorrect, switch off immediately and check the supply polarity, the orientation of diode D1 and the 7805 regulator.

If the reading is correct, switch off and install IC1 in its socket. Make sure that this device is orientated correctly and that all its pins go into the socket. IC2 & IC3 should also now be installed if you are also using sockets for these devices.

Remote control coding

Before testing, you will need to set up the remote control coding. The first step is to decide whether you will be using a TV, satellite or CD player code on the remote, then configuring the jumpers on the 10-Channel Remote Control Receiver accordingly – see Table 1.

Omitting both the CODE1 & CODE2 jumpers selects the TV code; installing the CODE1 jumper only selects SAT1; installing the CODE2 jumper only selects SAT2; and installing both jumpers selects the CD player code.

That done, the correct code must now be programmed into the remote. This involves selecting TV, SAT1, SAT2 or CD on the remote (to agree with the 10-Channel Receiver) and then programming in a 3-digit or 4-digit number for a Philips device.

Most universal remote controls can be used, including the Altronics A-1012 and the Jaycar AR1726. **For the Altronics A1012, use a code of 023 for TV mode, 242 for SAT1, 035 for SAT2 or 083 for a CD player. Similarly, for the Jaycar AR1726, use 103 for TV, 1317 for SAT1 or 1316 for SAT2.**

In the case of other universal remotes, it's just a matter of testing the various codes until you find one that works. There are usually no more than 15 codes (and usually a lot less) listed for each Philips device, so it shouldn't take long to find the correct one.

Note that some remotes may only work in one mode (eg, TV but not SAT). For example, if you have a Digitor

Darlington Saturation Voltage In The ULN2003 Devices

According to the ULN2003 data sheet, the output saturation voltage of each Darlington output stage is typically 1.3V @ 350mA (but can be as high as 1.6V). And it's typically 1.1V @ 200mA and 0.9V @ 100mA.

This means that with a supply of exactly 12V and a load drawing 350mA, the load will typically see just 12V - 1.3V - 0.2V (the Schottky diode voltage) = 10.5V. And it could be less than that depending on how much current other channels are drawing, the temperature and so on.

As a result, the Darlington configuration results in a voltage across the load that's substantially below the 12V supply voltage and while most 12V relays will happily run off 10.5V, other loads such as 12V LEDs may not. In fact, 12V LED lamps and 12V LED strips would probably be quite dim if switched using this unit because of the Darlington saturation voltage.

This can be slightly improved if the positive power supply terminal of each load is connected directly to the 12V supply, ie, bypassing D1. And, in fact, this will be necessary if the load total exceeds 1A, as D1 is only rated as 1A DC.

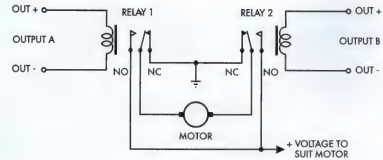


Fig.4(a): using two outputs to drive a motor in forward & reverse:
(1) Both outputs set for momentary operation. In this case, pressing (and holding) the button for Output 'A' activates Relay 1 and causes to the motor to rotate one way, while pressing the button for output 'B' activates Relay 2 and causes the motor to rotate the other way.
(2) Both outputs set for toggle operation. If both outputs are off at power-up, the motor will be stopped until one of the outputs is toggled (its direction will depend on which output is turned on). Alternatively, if one output is high and the other low at power-up, then the motor will run as soon as power is applied. The motor can be stopped and reversed by toggling the outputs.
(3) One output momentary and the other toggle. If the toggle output is high at power-up, the motor will immediately run. It can be stopped temporarily by pressing the button for the momentary output, or stopped permanently by pressing the button for the toggle output.

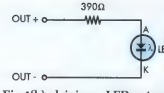


Fig.4(b): driving a LED output.

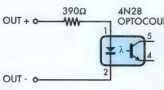


Fig.4(c): driving an optocoupler.

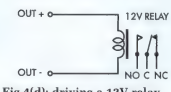


Fig.4(d): driving a 12V relay.

Table 2: Setting The Outputs For Momentary Or Toggle Operation

Step 1	Step 2	Step 3 (Toggle Operation Only)
Press Channel Up, then press channel number to set	Press "0" for momentary operation or "1" for toggle	Press "0" for output off at power up, "1" for output on

4-in-1 remote, you can use 5005 for TV1 but there's no suitable code for SAT. Similarly, if you have an AIFA RA7, you can use 026 for TV1 but again there's no suitable code for SAT.

If you are using infrared reception (ie, IRD1 installed), the receiver should now respond to the channel number buttons on the remote. When you press a button, the Acknowledge (ACK) LED should flash (to indicate that code is being received) and the indicator LED for that channel should light.

As mentioned, the 10-Channel Remote Control Receiver is initially set so that its outputs are momentary in operation. That means that a channel indicator LED should only light while its corresponding button on the remote is held down and should go out as soon as the button is released.

If it doesn't operate, check that IRD's lens is aligned with its hole in the case. Check also that the code programmed into the universal remote is correct and check that the SET input is open, ie, no jumper installed.

Note that the jumpers on the SET, CODE1 & CODE2 headers are only checked by the microcontroller at power up. So changing these jumpers with the power on will have no effect on the operation until the power is switched off and then on again.

Momentary or toggle

You can easily change one or more outputs to toggle operation to suit your particular application. In this operation mode, an output changes state when its remote button is pressed and remains in that state until the button is pressed again.

The output configuration is done using the hand-held remote. First, press the Channel Up (CH +) button and check that the Acknowledge LED on the receiver stays lit. Then press the number for the channel you wish to program. After that, pressing "1" will select toggle operation for that channel, while pressing "0" will select momentary. If momentary operation is selected, the Acknowledge LED will extinguish and the setting will immediately be stored.

If toggle operation (1) is selected, then you need to enter an additional number – either "0" or "1" – to select the state of the output at power up. A "0" sets the output to off at power up, while "1" will sets the output to on. Once you have entered this number, the Acknowledge LED will extinguish and the settings will be stored.

This procedure must then be repeated for any additional channels that require changing. Note that the Channel Down (CH-) button can be pressed before all the numbers are entered to exit the channel programming. There will be no change to the setting if this is done. In addition, the numbers for each setting must be entered within 12s, otherwise the program in the PIC micro will exit without making any changes.

Finally, Figs.4(a)-4(d) show how to use the outputs to drive various devices, including a 12V DC motor in forward or reverse. Note that while Fig.4(b) shows how to drive a single LED, it's also possible to drive series or parallel LEDs – just adjust the value of the current-limiting resistor accordingly. SC

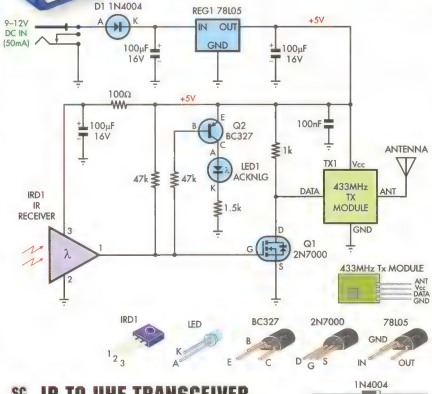
Extending The Range Of The Remote Control

Want to extend the remote control range or want it to operate without line of sight? You can with the IR To UHF Transceiver described on the following pages.

IR to 433MHz UHF Transceiver

Mates With 10-Channel Remote Control Receiver

Don't have line-of-sight between your infrared remote and the 10-Channel Remote Control Receiver? Or do you simply want more range or want it to work outdoors? This IR To UHF Transceiver will solve the problem.



SC 2013 IR TO UHF TRANSCEIVER

Fig.5: the circuit of the IR To UHF Transceiver. IRD1 picks up the infrared signal and its output drives the Data input of TX1 (the 433MHz transmitter module) via FET Q1. Transistor Q2 drives the Acknowledge LED (LED1).

THE WAY IN which this device works is straightforward: it picks up the coded signal from your IR remote and converts it to a 433MHz UHF radio signal. This is then picked up by the 433MHz receiver in the 10-Channel Remote Control Receiver, which decodes the signal and switches its outputs accordingly.

So, in effect, all it does is convert the remote's infrared signals into a radio link. The result: longer range and no more line-of-sight problems. If you want to control the 10-channel receiver from another room or outdoors, this is the way to do it.

Specifications

Power supply: 9-12V DC, 50mA
Infrared range: 10m line-of-sight
UHF range: 30m in open space

The transceiver is quite compact and operates from a 9-12V DC supply. In operation, it must be located within range of the infrared remote so that its IR receiver can pick up the remote's signals.

An acknowledge LED on the front panel lights when a valid infrared signal is being received and re-transmitted as a UHF signal.

How it works

Fig.5 shows the circuit details of the IR To UHF Transceiver. Its based on an infrared receiver (IRD1) and a 433MHz transmitter module (TX1) and not much else.

IRD1's pin 1 output is normally at 5V when no infrared signal is being received. This 5V "high" is inverted by Q1, an N-channel enhancement-mode FET. It turns on when its Gate is high and so the Data input of the UHF transmitter is normally low (ie, at 0V). This low voltage keeps the UHF transmitter off.

When an infrared signal is received from the remote, pin 1 of IRD1 pulses Q1 on and off. Each time FET Q1 turns off, a 1kΩ pull-up resistor at its drain pulls the Data input of TX1 to 5V and the UHF transmitter sends a signal.

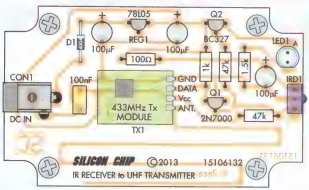
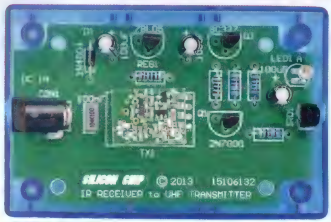


Fig.6: install the parts on the PCB as shown on this layout diagram. LED1 must be mounted with 12mm lead lengths, while the infrared receiver (IRD1) goes in with 4mm lead lengths.



The PCB clips neatly into the UB5 plastic case. Drill holes at each end for the DC socket and IRD1.

At the same time, each time pin 1 of IRD1 goes low, transistor Q2 turns on and drives the Acknowledge LED (LED1) via a 1.5kΩ current-limiting resistor. So this LED flickers upon receipt of infrared transmission.

Power for the circuit is derived from a 12V DC 100mA plugpack supply, with diode D1 providing reverse polarity protection. The nominal 11.4V supply at D1's cathode is then fed to 3-terminal regulator REG1 which provides a 5V supply for IRD1 and TX1 (the 433MHz transmitter).

Assembly

The IR to UHF Transceiver is assembled on a PCB coded 15106132 and measuring 79 x 47mm. This is housed in a UB5 plastic utility box measuring 83 x 54 x 31mm.

Fig.6 shows the parts layout on the PCB. Install the resistors and diode D1 first, taking care to ensure that the latter is correctly orientated. REG1, Q1 & Q2 can then be mounted but be careful not to get these mixed up.

Once these parts are in, install the capacitors but watch the polarity of the 100µF electrolytics. In addition, the tops of the electrolytics must be no more than 15mm above the PCB (so that they will later clear the case lid).

LED1 is mounted with the top of its lens 17mm above the PCB surface. That's done by pushing it down on a 12mm cardboard spacer inserted between its leads before soldering it to the PCB. Make sure the LED is orientated correctly, with its anode (longer) lead going to the pad marked "A".

The infrared receiver (RX1) can go in next. It's mounted on 4mm lead lengths so that its top is 10mm above the PCB.

The PCB assembly can now be completed by installing the UHF transmitter (TX1). This module is mounted horizontally and so its four mounting pins will need to be bent down at right angles for insertion into its PCB pads. The antenna for this transmitter is a part of the track pattern on the PCB, so there's no need to fit a separate antenna wire.

Final assembly

The PCB simply clips into the integral ribs of the UB5 case. **Before doing this, you have to drill a hole at each end to give access to the IR receiver and the DC socket.** These holes are both 6mm in diameter and should be centred 7mm down from the top of the base (and centred horizontally).

A 3mm hole must also be drilled in the box lid for the Acknowledge LED. The front panel label can be used as a template to determine the position of this hole. You can download this panel (in PDF format) from **www.siliconchip.com.au** (go to "Shop" and then "Panel artwork").

Once you have this file, print it out, attach it to the case lid and drill the LED hole to 3mm. A second copy of the artwork can then be printed onto photo paper and affixed to the lid using silicone or some other suitable adhesive. The hole for the LED can either be cut out or punched out with the back end of a 3mm drill bit.

In use, the IR To UHF Transceiver should be placed no closer than 1m to the 10-Channel Remote Control Receiver to prevent signal overload. In practice of course, the two are likely to be much further away than that and you should get reliable operation at distances up to 30 metres in open space.

What's coming

Finally, we plan to publish a version of this IR To UHF Transceiver that fits inside an IR remote control. We also plan to publish a companion UHF To IR Receiver unit so that trhe two can be used as an IR range extender with any equipment. SC

Parts List

1 PCB, code 15106132, 79 x 47mm
1 front panel label, 78 x 49mm
1 433MHz transmitter (TX1), (Jaycar ZW-3100, Altronics Z 6900)
1 UB5 utility case, 83 x 54 x 31mm
1 PCB-mount DC socket

Semiconductors

1 infrared receiver, TOSOP4136 or similar (RX1)
1 2N7000 N-channel enhancement-mode FET (Q1)
1 BC327 PNP transistor (Q2)
1 78L05 regulator (REG1)
1 1N4004 1A diode (D1)
1 3mm blue high-brightness LED (LED1)

Capacitors

3 100µF 16V PC electrolytic
1 100nF MKT polyester

Resistors (0.25W, 1%)

2 47kΩ
1 1kΩ
1 1.5kΩ
1 100Ω

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.

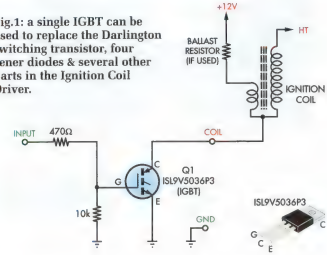


Fig.1: a single IGBT can be used to replace the Darlington switching transistor, four zener diodes & several other parts in the Ignition Coil Driver.

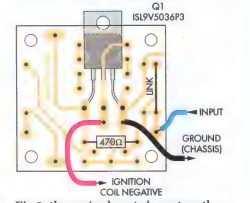


Fig.2: the revised parts layout on the PCB for the Ignition Coil Driver.

Simplifying the Ignition Coil Driver

The Ignition Coil Driver used with the Programmable Ignition published in March, April & May 2007 can be substantially simplified by replacing the Darlington transistor with an IGBT (Insulated Gate Bipolar Transistor) specifically intended for driving ignition coils, eg, as used in the High Energy Ignition published in November 2012.

As well as the Darlington, the original circuit on page 78 of the April 2007 issue required two transistors, a 5W resistor, four clamping zener diodes plus a capacitor and some resistors. The revised circuit requires only the IGBT, a 470Ω gate resistor and 10kΩ pull-down resistor – see Fig.1.

The circuit can be built using the original PCB as shown in Fig.2. The IGBT mounts beneath the PCB in the same way as the Darlington mounts, using TO-218 or TO-220 insulating washers and an M3 Nylon screw plus nut to secure the metal tab to the diecast case.

Where the Ignition Coil Driver is used independently from the Programmable Ignition, it may be required to operate with the reverse sense. That is, instead of the coil "charging" when the input signal is high and firing when low, the ignition coil is required to charge with a low input and fire on a high input signal.

An additional transistor can be used achieve this, as shown in Fig.3, and the resultant PCB component layout is shown in Fig.4. Note that the BC337 is labelled as Q3, to agree with its position on the PCB (coinciding with the original circuit in March/May 2007).

When Q3 is off, its collector is pulled to 12V via a 1kΩ resistor and this drives the IGBT gate directly via the forward biased diode D1. When Q3 is switched on, the IGBT's gate capacitance is discharged via the 1kΩ resistor that's connected in parallel with diode D1. This turns off the IGBT and resultant collapse of the ignition coil's magnetic field generates a high voltage to fire the spark plug.

John Clarke,
SILICON CHIP.

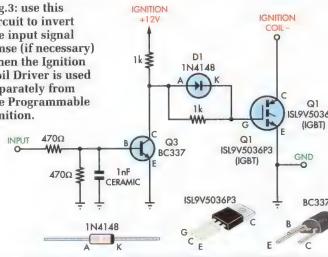


Fig.3: use this circuit to invert the input signal sense (if necessary) when the Ignition Coil Driver is used separately from the Programmable Ignition.

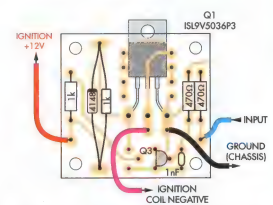
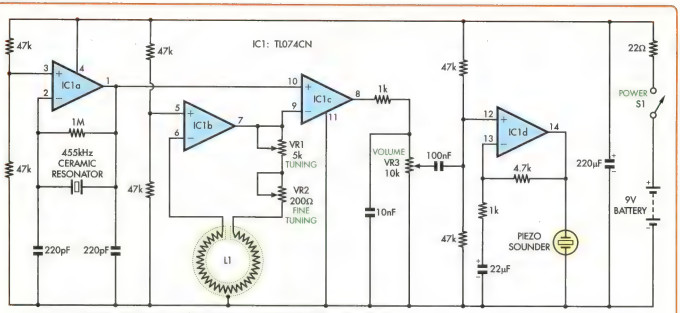


Fig.4: the revised parts layout incorporating the IGBT (Q1) and inverting transistor Q3.



L1 = 70 TURNS OF 0.315mm ECW, ID 100mm, WITH FARADAY SHIELD (SEE TEXT)

Metal detector uses a TL074 quad op amp

This metal detector is built around a TL074 quad op amp configured as a beat frequency oscillator (BFO). It will sense a coin, 25mm in diameter, from 120mm away or larger metal objects at a distance of half a metre in air, depending on the size of object and the type of metal.

Two op amps, IC1a & IC1b, are configured as feedback oscillators. IC1a has its frequency fixed by a 455kHz ceramic resonator and serves as the reference RF oscillator. It is biased to the mid-point of the supply voltage by a voltage divider consisting two 47kΩ resistors.

IC1b functions as a search RF oscillator with its frequency determined by the inductance of L1, series potentiometer VR1 and trimpot VR2. IC1b is biased in the same way as IC1a.

The outputs of the two oscillators are fed into IC1c which is connected as a comparator but operates as mixer. Its output is an audio tone which will be the difference between the frequencies of the two oscillators.

Tuning potentiometer VR1 and fine-tuning trimpot VR2 are adjusted to set the frequency of the search oscillator to generate a zero beat or a very low audible frequency when the search coil is not close to any metallic object. Bringing the search coil close to a metal object changes the search oscillator frequency and so the difference frequency rises as the search coil approaches the object.

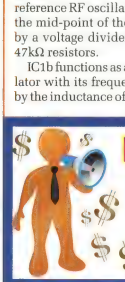
The resultant tone from IC1c is fed to a 10kΩ volume control and then to op amp IC1d which functions as an audio amplifier to drive a piezo sounder.

A low-pass filter (1kΩ and 10nF) removes the RF at the output of the mixer. The audio signal from volume control VR3 is then coupled to the non-inverting input (pin 12) of IC1d via a 100nF capacitor.

The search coil is made by winding 70 turns of 0.315mm-diameter (30SWG) enamelled copper wire around a 100mm-diameter former (eg, PVC pipe). The completed loop is then removed from the former and firmly taped all around with insulating tape. A Faraday shield is then made by wrapping narrow strips of aluminium around it.

Make sure that the shield has a 10mm gap at one point, so as not to make a shorted turn. A short length

continued on page 71



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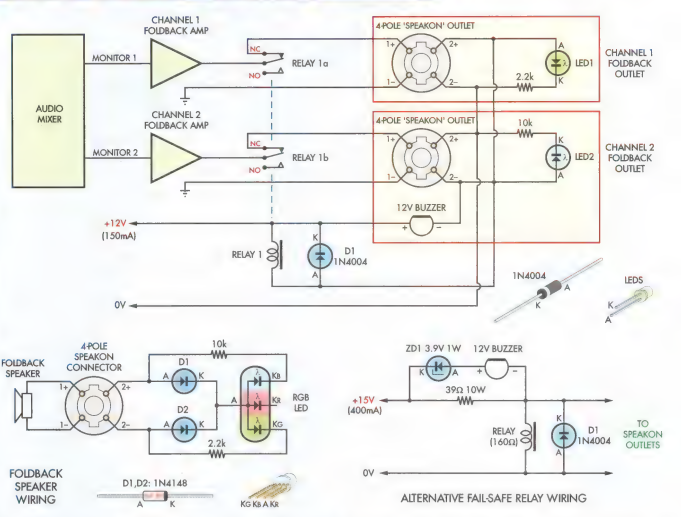


Dual-foldback loudspeaker indicator & protector

Most bands will have one or more foldback loudspeakers (wedges) that project the sound back toward the musicians so that they can hear themselves. The wedges are all daisy-chained together, effectively connecting the speakers in parallel to be driven by a single amplifier.

The sound mix in the foldback wedges is independent of the front-of-house speakers. Monitor controls on the audio mixer provide for independent level settings for each musician and vocalist. That can differ compared to the "front of house" loudspeakers sound mix.

Another different sound mix may also be necessary within the foldback wedges because some musicians will require a different sound mix to others in the band. In this case, a second foldback channel will be required. This can be provided for using a second monitor channel on the sound mixer and driven via a second amplifier. If a second monitor channel is not available on the sound mixer, generally an Effects channel can be used if it operates in a similar manner to the Monitor channel (ie, it is not altered in level by the main fader controls).

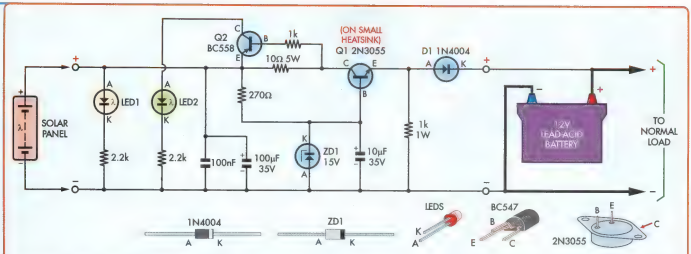
With two separate foldback channels, daisy chaining of the wedges will inevitably mean that the two channels may at some time be interconnected in error. That will have the foldback amplifiers driving each other. At best the amplifiers will shut down if they have short-circuit protection. If not there is the real possibility of amplifier damage.

With the circuit presented here, any interconnection between channels will open the connection between the amplifiers and loudspeakers plus sound an alarm.

LED indicators are included, with a separate colour used for each channel. One LED is at each channel's foldback outlet. In addition, an RGB LED within each foldback wedge will indicate when it is connected and, by its colour, to which channel it is connected to.

These colours match the colours of the control knobs on the sound mixer, ie, green for Monitor (channel 1) and blue for Effects (channel 2). These colours are also matched using an RGB LED in the foldback speaker wiring, as shown on the circuit at lower left. Plugging the foldback speaker in channel 1 lights the green LED, while plugging it into channel 2 lights the blue LED.

The system relies on the foldback loudspeakers using 4-pole Neutrik



Solar-powered 5W trickle-charger for 12V SLA/LA batteries

This circuit ensures that no more than 13.8V is fed to a 12V sealed lead acid battery from a 5W solar panel. Without the circuit, the solar panel could over-charge and damage the battery.

The particular solar panel used was a Jaycar 12V 5W unit (Cat ZM-9091) but similar units would be suitable. The unloaded voltage from the panel in full sunlight can reach 22V and it can deliver up to 370mA.

In essence, Q1 functions as an emitter follower and has its base voltage set by a 15V zener diode (ZD1). The output voltage at Q1's emitter will be around 14.4V and this will be further reduced to 13.8V via diode D1.

Transistor Q2, the 10Ω resistor and LED2 provide an indication when the charging current is more than about 50mA. It works as follows: once the current through the 10Ω sensing resistor exceeds more than 50mA, the resulting voltage across it will forward-bias the base emitter junction of PNP transistor Q2. This turns on to drive LED2.

Higher currents will naturally develop more voltage across the sensing resistor but this will not damage the transistor because of the 1kΩ resistor in series which limits the base current.

The MJE3055 was fitted with small heatsink. If a larger solar panel is used, a larger heatsink must be fitted to this transistor.

Warwick Talbot,
Toowoomba, Qld. ($50)

Editor's comment: note that this circuit has no protection in the case of the battery being connected back to front. If that happens, heavy current will flow via the now forward-biased zener diode ZD1 and the base-emitter junction of Q1. Both components are likely to be instantly blown. Adding a fuse is unlikely to be effective.

Speakon connectors. It also relies on the interconnecting leads being wired for all four poles. If your interconnecting leads are only wired for two poles, they will need to be rewired. The Jaycar WB-1762 4-way speaker cable is ideal. This is a flexible lead with four 40 x 0.16mm insulated wires. The cross sectional area is 0.8mm^2 and is suited for 8A. With the Speakon connectors used in loudspeakers, the 1+ and 1- terminals are for the loudspeaker wiring, leaving the 2+ and 2- terminals spare.

These spare terminals are connected to LED indicators and to a 12V DC supply via a relay coil. Note that the channel 1 outlet has the 2+ terminal connected to +12V via a relay coil, while the 2- terminal is connected 0V. For channel 2, the connections are reversed. Normally minimal current flows through the relay coil and is only the LED current. This is insufficient to activate the relay.

However, if the two channels are interconnected, the supply to the LEDs is shorted and the relay coil is energised, opening the relay contacts and disconnecting the foldback amplifier outputs. The buzzer also sounds.

We used the Altronics S4310 DPDT cradle relay and the S4318A socket base. The 12V supply is a 12V 150mA plugpack that is powered at the same time as the foldback amplifiers. Bridge-mode amplifiers will require a 4PDT relay or two DPDT relays to switch all outputs.

Note that the circuit is not fail-safe. This is where failure of the 12V supply will not disconnect the amplifiers. An alternative fail-safe arrangement is shown and uses a 15V 400mA supply instead. The relay contacts for the amplifier will need to connect to the COM and NO contacts.

John Clarke,
Silicon Chip

Metal detector: continued from page 69

of wire should then be connected to one end of the shield, after which it should be further wrapped in insulating tape.

The coil can then be attached to a non-metallic baseplate (eg, plywood) and connected to the circuit using microphone cable. The shield wire of the coil is connected to the 0V (ground) rail of the circuit using the cable's shield.

Mahmood Alimohammadi,
Teheran, Iran. ($60)

"A Lump In The Coax"

Mini Audio Mixer

We've published a number of audio mixers, large and small, over the years but they've all been "general purpose". Not that that's a bad idea – it's just that when you need one for a specific purpose, you need a specific purpose mixer!

In another life, I do a lot of commentary and announcing at surf lifesaving carnivals and also do my share of MC-ing at other venues. But I have come across a problem many, many times and just as often longed for a solution to that problem. This is it!

So what's the problem?

I'm sure that anyone working in small clubs or similar venues have had this dilemma. Many clubs – as do many other community centres, halls, schools and so on – have a reasonable (and sometimes excellent) public address system installed.

Surf lifesavers use it to warn swimmers of dangers, they use it to provide information to the beach-going public and from time to time it's there for commentary when the club runs a carnival.

The problem is that surf clubs, like the vast majority of "public" halls and sports venues, suffer badly from knob-twiddlers and system stuff-upperers: presumably well-meaning people who think they know what they are doing, invariably putting the PA system into shock (if not cardiac arrest!). You know what they say, "a little knowledge is a dangerous thing . . .".

For example, the hirers who want "more sound" and add in a couple of "real good" speakers from their home hifi. Except they don't know that most PA systems are wired with 100V speaker lines. . .

Others simply "make adjustments" which end up being maladjustments!

Design by Nicholas Vinen
Words by Ross Tester and Nicholas Vinen

Lock the PA away!

An increasing number of venues which I visit have their PA system firmly locked away in a cupboard so that no-one except the person responsible for the system can get at it. And, of course, that person is never around when needed.

The PA often simply has an accessible on/off switch while all controls are pre-set to "typical" levels, so that it

really is simple enough for any idiot to use. Idiot being the operative in many cases.

Even if it isn't locked up, getting to the business end of the system to plug anything else in – an MP3 player, for example – is often near (or totally) impossible.

(I'm sure that manufacturers put all inputs and outputs on the back of amplifiers not just to tidy up the wiring but to cause the most frustration!)

Such systems invariably have either an XLR socket mounted on the locked box or a coax cable emerging from it, to which is attached a wired microphone (invariably on a too-short lead) – and that's it.

Many have given up on wireless microphones, usually because the mic itself keeps on disappearing and/or they've suddenly found their wireless microphone is suffering from all sorts of strange interference. (See the feature earlier in this issue – wireless microphones and digital TV).

So you get to a venue and find all you have to work with is a wired microphone which doesn't even reach the balcony, so you can actually see what's happening on the beach (I always carry a long XLRF-XLRM "extension" mic lead with me these days!).

But that's it: if you need to add music, all you can do is do it acoustically (eg, the MP3 player's speaker to microphone) which invariably sounds awful.

If you want to use a wireless microphone (for ceremonies, interviews, etc) away from the system – tough luck! And if there are two or more announcers, you're continually swapping the fixed mic back and forward.

It's all pretty unsatisfactory – and unless you've been in the situation, you probably won't appreciate just how frustrating it all is.

Which started us thinking . . .

While it's not something every reader would need to worry about (indeed, very few will ever have the problem) we thought, "why not come up with a mini mixer specifically designed for this purpose".

Then we reasoned that such a mixer would be popular with a lot of others who have PA systems – schools, for example – and wanted to be able to lock it away so that the twiddlers couldn't . . . twiddle.

If at any time they wanted extra inputs, here would be the ideal way to do it. We mention schools here mainly because so many electronics-savvy teachers have told us that non-savvy "expert" colleagues are the bane of their lives!

And we also thought of all those venues that have microphone sockets (XLRs) spread around the building wired back to the PA amp, somewhere, so that mics could be plugged in and used anywhere. With this Mini Mixer, such installations would be so much more versatile and usable.

Specifications: (22Hz-22kHz bandwidth, unweighted, 50mV RMS in/out unless otherwise stated)

Signal-to-noise ratio: >65dB
Total harmonic distortion plus noise: 0.06% (1kHz)
Common mode rejection ratio: >40dB (typically 55dB)
Frequency response: 50Hz-35kHz (-3dB)
Gain: ~1 for microphone input, 0-0.25 for other inputs
Signal handling (microphone input): at least 1V RMS
Signal handling (other inputs): 0.2-2.5V RMS for 50mV output
Supply current: 0.5mA (typical)
Battery: CR2032 (3V Lithium), 3.7V Li-Po or 9V alkaline/dry cell
Battery life: 200+ hours with CR2032, 2000+ hours with Li-Po
Operating voltage: minimum 2.1V, nominal 2.7-4.2V
Li-Po charger input: 5V DC @ up to 500mA

Our ideas

A typical PA system uses either a dynamic or electret microphone (the latter less usual as they tend to be more easily damaged). These mics usually have an output in the region of 10-50mV and any microphone worth its name uses XLR connectors – there's a male XLR socket built into the microphone, the coax mic lead has a female plug to match and a male plug back at the amplifier to match the female input socket.

What if we were to come up with a mixer which simply inserted between the mic lead and the microphone and effectively gave a "straight through" connection for that microphone – in other words, act as if it wasn't there? That way there would be no difference in the normal operation of the PA.

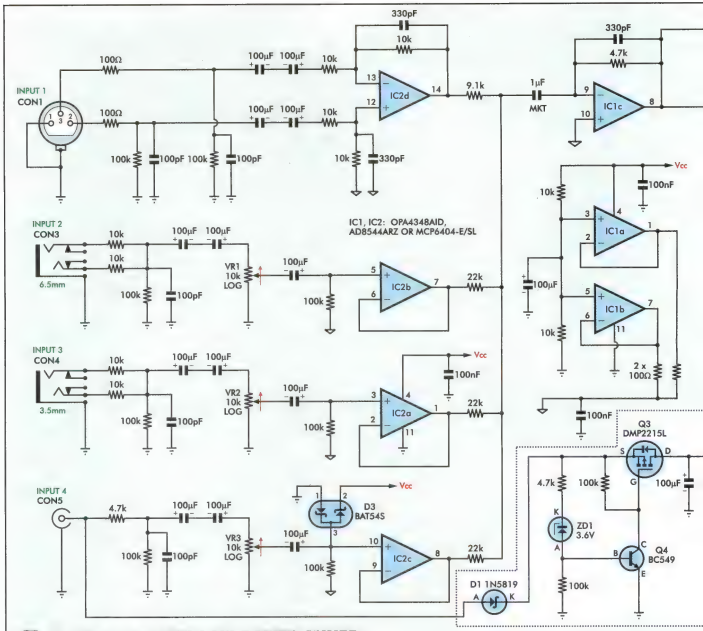
It could almost be regarded as a "lump in the coax".

But that same mixer could also accept a couple of other inputs – say from an MP3 or CD player for music and from a wireless microphone receiver. The beauty of both of these is that they would be expected to be much the same output level – perhaps 1V, maybe less – which would make the mixer inputs virtually universal.

We would want to make the mixer battery-operated for convenience so would need a very low power op amp if we wanted the battery to last any length of time. Speaking of batteries, a 3.7V Lithium-Ion (or even LiFePO4) would be eminently suitable, given the right design.

With very low drain, even a button cell could be used – or we could use a mobile phone battery which are very flat and give a very respectable output – that would theoretically last for weeks, if not months.

Shown here not too far off life-size, the Mini Mixer has XLR input and output sockets on the end and 6.35mm, 3.5mm and RCA sockets along one side.



SC 0013 "LUMP-IN-COAX" LOW POWER MIXER

Fig.1: the circuit is quite conventional for an audio mixer, albeit with a few clever refinements (eg low-voltage op amps) for operating at very low power. Input 4 doubles as a charging connection for Li-Po battery, if fitted. The back-to-back (series) 100µF capacitors are used because two of these are significantly cheaper than one non-polarised 50µFcapacitor.

And finally, the whole thing would want to be quite small, with a minimum of controls to make it as foolproof as possible. Let's not worry about tone controls or other "niceties".

Our design

We've come up with a mini-mixer that fits all the criteria above (and then some!). In fact, it has some rather snazzy features and offers performance that is nothing to be sneered at!

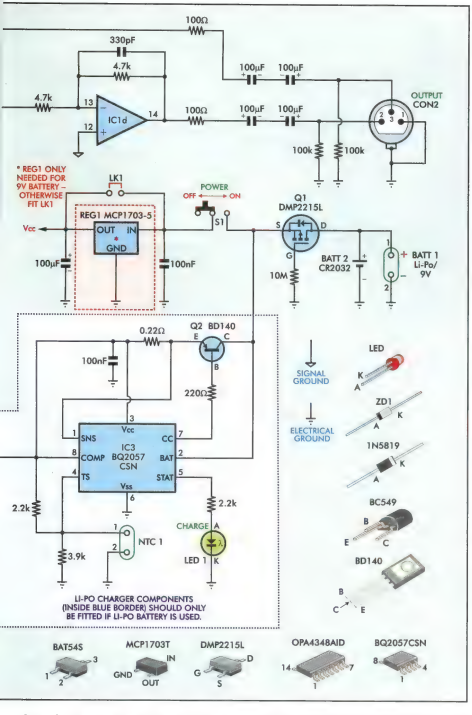
It's small (built into a 120 x 93.5 x 35mm diecast box). It has minimal controls – just a "preset"-type gain control for each of the three inputs and these don't even have knobs (again to discourage the twiddlers).

We used mini pots with "screwdriver slots" on the end – they emerge just far enough from the front panel to fit a fingernail! (OK, use a small flat-bladed screwdriver if you must!).

There are five sockets: an XLR female and male on the end to accept the microphone lead and the lead to the amplifier, a 6.35mm "phono" socket, a 3.5mm mini phono socket and an RCA socket. The larger phono sockets are often used on wireless microphones while the 3.5mm mini sockets are very commonly used on MP3 and other small music players, radios, etc, normally as headphone sockets.

But we've been particularly clever with the RCA socket: feed it with audio signal, it acts as you would expect. But if you feed it with 5V DC (eg, from a USB socket or plugpack), it also serves as the charging point for the internal battery; more on this shortly.

The only other control is the power switch, necessary if you use the on-board CR2032 lithium battery but almost redundant if you use a larger



phone battery, as mentioned earlier.

One point to note: a lot of mobile phones, etc use headphones fitted with 2.5mm ultra-mini plugs. We haven't allowed for a 2.5mm socket but 2.5 to 3.5mm adaptors are very common and very cheap.

Finally, it's designed to suit dynamic microphones only and then only those that use XLR plugs. No provision has been made for electret phantom power.

Circuit description

The balanced microphone signal from CON1 is converted to an unbalanced signal which is then mixed with the signals from the other three inputs. The result is then again converted to a balanced signal at output CON2. For all intents and purposes, the amplifier won't even know it's there!

The gain of the balanced-unbalanced-balanced path is close to unity while the gain for the other three channels can be varied from one quarter down to zero.

Inputs CON3 (6.5mm jack socket) and CON4 (3.5mm jack socket) can accept either mono or stereo plugs; if a stereo signal is applied, it is mixed down to mono. CON5 (RCA socket) is mono only.

Potentiometers VR1-VR3 are used to adjust the level of these signals respectively and in each case, the result is then buffered by an op amp and then fed to the mixing node.

Why no volume control for the microphone input? The microphone volume is adjusted via the PA amplifier, so we just need three pots to set the relative level for the other inputs. Now let's look at the circuit's operation in a little more detail.

Balanced input

The balanced microphone delivers identical but opposite polarity (out-of-phase) signals to op amp IC2d which is configured for balanced inputs but has an unbalanced (ie, single-ended output at pin 14. Both signals pass through identical RF filters comprising 100Ω series resistors and 100pF ceramic capacitors while two 100kΩ resistors provide a DC bias to 0V.

Following the RF filters, both signals are AC-coupled through back-to-back 100µF capacitors to the inputs of IC2d.

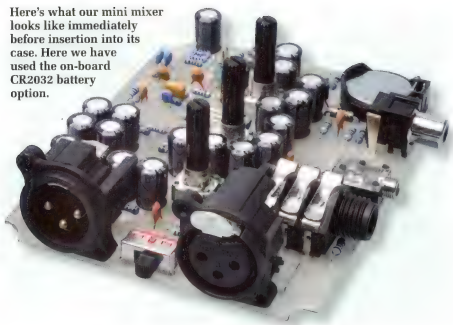
Note that the signal ground for IC2d (and indeed, all the op amps) has a different symbol than power supply ground and is actually at half-supply, ie, about 1.5-2V.

We have used back-to-back electrolytics here because PA gear can be connected to other equipment that might have phantom power, might be faulty, etc. So all inputs and outputs tolerate ±48V DC without damage.

Standard electros though are usually cheaper and smaller than non-polarised types; two 100µF 50V capacitors connected in this manner are equivalent to a 50µF 50V non-polarised capacitor.

IC2d converts the balanced signal from the microphone to unbalanced while largely rejecting unwanted signals picked up in the cable (eg, hum and noise). The output of IC2d is the signal from pin 2 of CON1 minus the signal at pin 3. So an extraneous signals picked up equally by both lines in the microphone cable will be cancelled out or at least heavily attenuated.

The two 330pF capacitors roll off the frequency response of this amplifier, forming a low-pass filter with a -3dB point at around 48kHz, rejecting signal which may be picked up that is above regular audio frequencies but low



Here's what our mini mixer looks like immediately before insertion into its case. Here we have used the on-board CR2032 battery option.

enough to pass through the RF filters.

Other inputs

The circuits for unbalanced inputs 2 and 3 (CON3 & CON4) are identical. Two 10kΩ resistors down-mix the stereo to mono; if a mono jack plug is inserted, these are effectively paralleled to form a single 5kΩ resistor. A 100pF capacitor in combination with this forms the RF filter and a 100kΩ resistor provides a DC path to ground.

The signal is then AC-coupled to volume control pot VR1 (or VR2). The output from its wiper is AC-coupled again to ensure that no DC flows through VR1, which would cause noise when the pot is turned. A 100kΩ resistor sets the DC bias to half-supply and the signal is then buffered by voltage follower IC2b (or IC2a) before being applied to the mixer stage.

The signal path from the mono RCA connector (CON5) is the same as above but being mono, a single 4.7kΩ series resistor is used rather than a pair of 10kΩ resistors. Also, CON5 can be used to charge the onboard Li-Po battery, as we shall explain later. In this case, dual schottky diode D3 prevents current flowing into op amp IC2c as the coupling capacitors charge when DC is applied to CON5.

The mixer

The four signals are fed to a virtual earth mixer based around inverting amplifier IC1c which has a 4.7kΩ feedback resistor from its output (pin 8) to inverting input (pin 9). Again there is a 330pF roll-off capacitor for further attenuation of any signals above the audio band.

The output of IC2d is applied to the mixing node via a 9.1kΩ resistor and 680nF AC-coupling capacitor. This capacitor forms a high-pass filter with IC1c's feedback resistor to remove low bass, giving a -3dB point around 50Hz. This is primarily to deal with microphone thump, etc but also attenuates any 50Hz hum which may be picked up by about 3dB.

The other three inputs are applied to the mixing node via 22kΩ resistors, giving them a gain of about 0.21 (4.7kΩ÷22kΩ). The signals from these inputs will generally be at or around line level, ie, in the range of 0.5-2V RMS while the microphone signals will be much lower at around 50mV. So this attenuation gives VR1-VR3 a more useful adjustment range.

Note also that the gain in this stage for the microphone input is 4.7kΩ÷9.1kΩ = 0.52. The following unbalanced-to-balanced converter has a gain of two so these cancel out.

The mixed signal from the output of IC1d is applied to pin 3 of output CON2 via a 100Ω current-limiting resistor and another pair of AC-coupling capacitors with a 100kΩ DC bias resistor to ground. The mixer stage (IC1c) is inverting so its output goes to the inverted signal pin (pin3) of the balanced (XLR) connector, CON2.

For the non-inverted output (pin 2 of CON2), the signal from IC1c is inverted again, without gain, by IC1d which gives it the same polarity as the input signal.

Virtual earth

The two remaining op amp stages out of the eight (IC1a and IC1b) are used to create and buffer the half supply virtual earth. This is generated by a pair of 10kΩ resistors connected across the supply and filtered with a 100µF capacitor, so that it is effectively grounded for AC signals.

Voltage followers IC1a and IC1b drive the virtual earth rail through 100Ω resistors with a 100nF capacitor to ground. The capacitor reduces the impedance of this rail at high frequencies, where the impedance of the op amp outputs could be quite high, while the 100Ω resistors isolate this capacitance from the op amps to avoid oscillation.

Li-Po charger

There are three basic options for the power supply: an on-board CR2032 Lithium button cell, a 9V battery or 3.7-4.2V rechargeable Lithium Polymer (Li-Po) cell. The latter option offers the longest battery life, potentially in the thousands of hours, with the bonus that you don't have to open up the case to change the battery if it goes flat.

Instead, you simply apply 5V DC to the central pin of CON5 (the RCA connector) and an internal charging circuit brings the cell back up to full charge. Charge current starts at around 500mA and drops off as the cell approaches full charge, so for a typical 1000mAh cell, a full charge takes up to two hours. So for a two-hour charge you could get up to 2,000 hours operation!

When 5V DC is applied to CON5, schottky diode D1 becomes forward biased and current flows through 3.6V zener diode ZD1 and turns on NPN transistor Q4. Q4 in turn pulls the gate of P-channel Mosfet Q3 low, allowing the power to flow through D1 and Q3 into the 100µF supply bypass capacitor for the battery charger circuit.

This isolates the charger circuit from any signal applied to CON5 during normal operation, up to at least 2V RMS (2.8V peak). When Q4 is off (ie, no charging voltage is applied), Q3's gate is pulled to its source voltage by a 100kΩ resistor, keeping it switched off. Similarly, a 100kΩ resistor ensures that a small amount of leakage current through ZD1 will not turn on Q4.

IC3 (BQ2057C) is a dedicated

siliconchip.com.au

Lithium Ion/Lithium Polymer charging IC. There are four versions of this IC, to suit one and two cell batteries with 4.1V or 4.2V charge termination voltages, depending on the cell chemistry. Most modern Li-Po cells can be charged safely to 4.2V so that is the version we have used (see panel for details).

Li-Po cells need a constant current/constant voltage charge cycle with accurate termination to give a good life and that's all handled by IC3. It controls PNP power transistor Q2 to regulate the current and voltage to the cell, with current sensed by the voltage drop across the 0.22Ω shunt resistor. IC3 turns LED1 on only while the cell is charging – the LED does not waste power in normal operation.

IC3 has provision for an NTC thermistor which can be attached to the cell to monitor its temperature so it can stop charging if it gets too high. This is optional; if you want to fit an NTC thermistor, it should be a nominally 10kΩ type and wired across the NTC1 terminal. Otherwise, connect a 10kΩ resistor across this terminal.

Note that all the charging circuitry from D1 through to Q2 may be omitted if you aren't planning to use a Li-Po battery to power the unit.

Power supply

The Li-Po battery is charged via P-channel Mosfet Q1 which prevents damage in case the cell is connected backwards. With the cell in the correct orientation, Q1's gate is pulled to ground while its source goes high (bootstrapped by its body diode) and thus it switches on, allowing power to flow from the cell to the circuit and also allowing charge current to flow into the cell from Q2.

Otherwise, Q1's gate is pulled high and being a P-channel type, it remains switched off. In this state, its body diode is also reverse-biased so no current can flow.

Slide switch S1 controls power to the mixer but the unit can still be charged while off as the charging current does not flow through S1.

REG1 is only needed if you want to run the circuit off a 9V battery, as IC1 and IC2 have a maximum operating voltage of 5.5V. The MCP1703-5 has a very low quiescent current so that it doesn't spoil the mixer's low current drain. If using a Lithium or Li-Po cell, omit REG1 and fit LK1 instead (but you

Parts list – "Lump in The Coax" Mini Mixer

1 diecast aluminium enclosure, 120 x 93.5 x 35mm (Altronics H0454, Jaycar HB5067)
1 PCB, coded 01106131, 110 x 85mm
1 PCB-mount right-angle female compact XLR socket (CON1) (Altronics P0875)
1 PCB-mount right-angle male compact XLR socket (CON2) (Altronics P0874)
1 PCB-mount switched 6.35mm stereo jack socket (CON3) (Altronics P0073, Jaycar PS0195)
1 PCB-mount switched 3.5mm stereo jack socket (CON4) (Altronics P0092, Jaycar PS0133)
1 PCB-mount switched RCA socket (CON5) (Altronics P0145A, Jaycar PS0279)
1 right-angle SPDT slide switch (Altronics S2070)
2 2-way pin headers, 2.54mm pitch (BAT1, NTC1)
4 No.4 x 9mm self-tapping screws or M2.5 machine screws
1 M3 x 6mm machine screw and nut
1 200mm length 0.7mm diameter tinned copper wire
1 110 x 85mm sheet of insulating material (eg, PET)
1 lid label

Semiconductors
1 DMP2215L P-channel SMD Mosfet (Q1)
2 OPA4348AID* quad rail-to-rail micropower op amps (IC1, IC2) (element14 1706654)
* AD8544ARZ and MCP6404-E/SL are also suitable but with higher minimum operating voltage.

Capacitors
20 100µF 50V (Altronics R4827) (25V may be used with less margin)
1 1µF MKT/polyester (code 1U, 1.0 or 105)
5 100nF monolithic multi-layer [MMC] (code 100n, 0.1 or 104)
4 330pF disc ceramic (code 330p or 331)
5 100pF disc ceramic (code 100p or 101)

Resistors (0.25W, 1% unless otherwise stated)

1 10MΩ	12 100kΩ	3 22kΩ	11 10kΩ	1 8.2kΩ
5 4.7kΩ	1 3.9kΩ	2 2.2kΩ	1 220Ω	6 100Ω

1 0.22Ω SMD 6331 (metric), 2512 (imperial)
3 10kΩ log vertical 9mm PCB-mount potentiometers (Altronics R1958)

Parts needed for CR2032 button cell operation
1 PCB-mount 20mm button cell holder (Altronics S5056, Jaycar PH9238)
1 CR2032 button cell

Parts needed for Li-Po cell operation
1 small 3.7V Li-Po cell with leads
2 2-way pin header plugs with crimp pins
1 BQ2057CSN Li-Ion/Li-Po charger (IC3) (element14 1652449)
1 BD140 PNP transistor (Q2)
1 DMP2215L P-channel SMD Mosfet (Q3)
1 BC549 NPN transistor (Q4)
1 1N5819 1A schottky diode (D1)
1 BAT54S dual series SMD schottky diode (D3) (Altronics Y0075, element14 1467519)
1 3.6V zener diode (ZD1)
1 3mm green LED (LED1)
1 10kΩ NTC thermistor, beta ~4000 (optional)
1 100mm length 4-way ribbon/rainbow cable
1 length double-sided, foam-cored adhesive tape
1 USB cable with type A connector at one end
1 RCA line plug

Extra parts for 9V battery operation (note: battery won't fit in specified case)
1 MCP1703-5 LDO micropower regulator, SOT-23 (REG1) (element14 1627178)
1 9V battery
1 9V battery snap with leads
1 2-way pin header plug with crimp pins
1 100mm length 4-way ribbon/rainbow cable

should fit the two bypass capacitors anyway).

Performance and noise

The performance for this mixer is pretty good considering the low voltage and power consumption.

Lower-power op amps almost always have more noise and less bandwidth than their higher-power counterparts. That is because, to reduce their power consumption, the standing current in both the input pair and the voltage amplification stage (VAS) is reduced.

Dynamic microphones have quite a low output signal level – typically below 50mV RMS. That, in combination with the higher input noise of low-power op amps, limits the signal-to-noise ratio of the mixer. In practice though, 65dB is more than adequate for PA work.

If you aren't happy with that, there's an easy solution – swap the OPA4348 op amps with noise of 35nV/sqrt(Hz) for a lower-noise, pin compatible part such as the TL974 which has just 4nV/sqrt(Hz). We expect that will improve the signal-to-noise ratio by around 10dB.

But it does so at the cost of much increased battery current of 16mA and somewhat reduced signal handling capability as the TL974 does not have a rail-to-rail input. If you decide to swap the op amps, you will definitely want to use a Li-Po battery.

iPod compatibility

If you want to connect an iPod to the 3.5mm input socket, you can do so but you may find that it's necessary to provide it with a lower value load resistance for it to operate correctly. This might apply to other MP3 players too although most are happy driving a high load impedance. The solution is simple: replace the 4.7kΩ series resistor at this input with a 100Ω resistor and change the 100kΩ DC bias resistor to 1kΩ.

This may mean though that input can no longer be used with other signal sources, which is why we didn't do it that way in the first place.

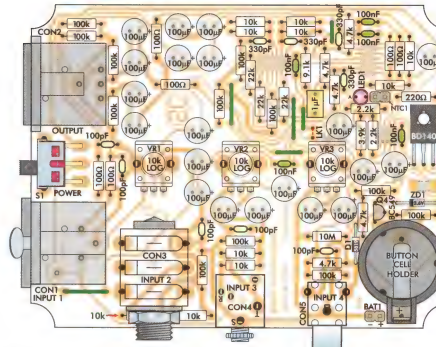


Fig.2: component layout for the mixer from the top (component) side. You have the option of using an on-board CR2032 button cell (as shown here), an external (rechargeable) Li-Po or even a garden-variety 9V type!

Construction

The prototype mixer was built on a single-sided PCB, coded 01106131 and measuring 110 x 85mm but production boards will be double-sided, eliminating the need for wire links (shown in green in the diagram above).

Start by fitting the SMDs, beginning with op amps IC1 and IC2. Locate pin 1, which is normally indicated with a dot or stripe. If you can't find that, check for a bevelled edge on the PCB package, also on the pin 1 side. Put a little solder on one of the IC pads and while heating that solder, slide the IC in place.

When it's lined up with its pads, double-check that the IC is orientated correctly then solder the rest of the pins. Then refresh the first one you soldered with a dab of extra solder. Remove any bridges with some solder wick.

Carefully examine the solder joints with a powerful light and magnifying glass; a bad joint at this stage could cause problems later and it's quite easy to get solder on one of these pads without it actually adhering to the component pin (something we've had

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10MΩ	brown black blue brown	brown black black green brown
❑	12	100kΩ	brown black yellow brown	brown black black orange brown
❑	3	22kΩ	red red orange brown	red red black red brown
❑	11	10kΩ	brown black orange brown	brown black black red brown
❑	1	8.2kΩ	grey red red brown	grey red black brown brown
❑	5	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.9kΩ	orange white red brown	orange white black brown brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	220Ω	red red brown brown	red red black black brown
❑	6	100Ω	brown black brown brown	brown black black black brown

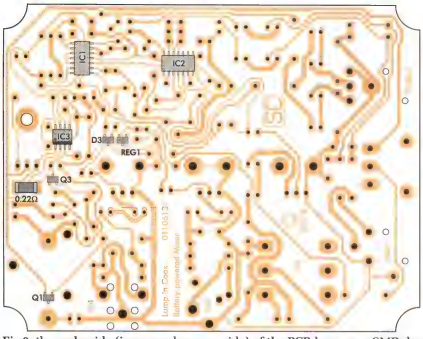


Fig.3: the underside (ie, normal copper side) of the PCB has seven SMD devices on it, as shown here and (partially) in the early prototype pic above right. These should be soldered in place before you start assembling the top side. While our prototype was a single-sided PCB, production boards will be double-sided.

happen on more than one occasion). If necessary, add some heat and/or solder to any suspect joints.

Now fit Mosfet Q1 in the same manner. It's smaller but the pins are widely spaced. The leads should sit on the PCB surface; if they are sticking up in the air like a dead cockroach, the part is upside-down.

If you will be powering the unit from a 9V battery, fit REG1 in the same manner.

But we believe that most constructors will want to use the Lithium or Li-Po options; if you do use a 9V battery, you will have to fit the unit in a larger case than specified.

If you are using a Li-Po and want the on-board charging facility, install the associated SMD components now, ie, D3, Q3, IC3 and the 0.22Ω shunt resistor using the same basic technique outlined above.

Through-hole parts

If you ordered the board from the SILICON CHIP webshop (or if it was supplied in a kit), it will already have the links as the top layer.

Otherwise (eg, if you etch your own single-sided board), fit the six wire links now (shown in green in Fig.2) using tinned copper wire, plus LK1 if you *aren't* using a 9V battery. Follow with the remaining resistors. Use the colour-code table as a guide but also check their values with a DMM.

Diodes D1 and ZD1 go in next but only if you are building the Li-Po version. In that case, you will also need to mount Q2 and Q4. For Q2, Bend its leads, feed them through the holes and then use the M3 screw to fasten its tab securely to the PCB before soldering the leads. The metal tab goes down, against the PCB (not as shown in the photo, which we changed).

Next, fit all the ceramic capacitors (disc and monolithic multi-layer). Then solder in the 3.5mm jack socket, button cell holder (if required), slide switch S1 and the two 2-way pin headers.

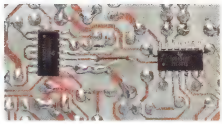
Follow with the single MKT capacitor and then the electrolytics; these are all the same value and in the same orientation, with the positive (longer lead) to the right side of the board.

You can now mount the larger connectors, CON1-CON3 and CON5, as well as the three vertical pots. Push these down firmly into the mounting holes before soldering the two tabs and three pins. If building the Li-Po version, fit LED1 now, at full lead length, with its anode (longer lead) to the left.

The PCB is now complete.

Connecting the Li-Po battery

We recycled a 3.7V 1500mAh "Huawei" Li-Po battery from an unloved mobile phone (the battery still charged



and held charge). We found (more by good luck than good management) that this 42 x 65 x 5mm battery fitted perfectly inside the case lid, alongside the pot shafts.

Even if you have to buy a new one, they're dirt cheap on ebay – for example, one the same as we used was $3.90 including postage from Hong Kong.

You can get Li-Po cells with leads attached but if recycling an old one, like ours, identify which pads correspond to positive and negative and then solder a couple of appropriately-coloured wires to these (eg, from ribbon cable).

Connect a two-pin header to the other end of this cable by stripping the ends of the wire, crimping the two small pins to them (both to the uninsulated and insulated sections) and then pushing them into the plastic block. We like to solder the crimped joint too but you have to be careful not to put much solder on or the pin may not go into the block.

For a 9V battery, you will need to attach a 2-pin plug to the wires from the 9V battery snap using the same method.

Charging cable

For the Li-Po version, you will also need to make a charging cable. You can charge from USB or a 5V DC plugpack or car adaptor.

To make a USB cable, take a cable with a Type A plug on one end and chop the other end off. Strip back some of the outer insulation, solder the white and green wires together and insulate them with small diameter heatshrink tubing.

Slide the rear of the RCA plug over the cable then solder the red wire to the centre pin and the black wire to the surround. Crimp the cable with the provided clamp and slide the rear cover back on. Plug it into a USB port and use a DMM to check that the centre pin is at +5V relative to the surround.

If charging from a plugpack, it's just a matter of fitting an RCA plug to the plugpack using a similar method.

If fitting an NTC thermistor to moni-

The Lump-in-the-coax mixer installed in its diecast case, ready for the lid (with appropriate label) to be screwed on.

tor the battery temperature, glue or otherwise attach it to the cell and run a couple of short leads back to another 2-pin plug as described above, to plug into the NTC1 header on the PCB. If you don't want to fit the NTC, solder or otherwise connect a 10kΩ resistor across the NTC1 header pins.

Testing it

Check the unit out before fitting it into the case. Apply 3-5V DC to the BAT1 terminals via a spare 1kΩ resistor and measure the voltage across that resistor with a DMM. You should get 0.5-0.75V. If it's much less, check the supply polarity and failing that, soldering and component placement on the PCB. If the reading doesn't drop below 1V after a few seconds, that suggests a short circuit or other problem (eg, incorrectly orientated component) which you will need to look for.

Assuming all is well, turn the pots all the way down, connect up the battery directly and attach a microphone and some sort of amplifier, as long as it has a "mic" input with either an XLR socket or you have an adaptor.

Switch on and speak into the microphone; check that the output sounds OK.

To test the Li-Po charger, leave the battery connected and plug in the charging cable. Unless the cell is already fully charged, LED1 will light. You can monitor the battery voltage with a DMM; it should rise to 4.2V (this might take a while if it's quite flat to start with).

If you built our USB Power Monitor (December 2012) then you can use this to check that the current draw is below 500mA and slowly drops as the cell charges.

Drilling the case

A drilling template and front panel artwork can be downloaded from www.siliconchip.com.au. Use these to mark the hole positions and drill them all to the sizes shown.

The holes will need to be accurately placed as the board only just fits in the case when they are in the right positions.

The largest (XLR) holes will need a tapered reamer – even so, you may still need to use a round file to finish them off (many reamers only go to 20mm).

Note that there won't be much "meat" left along the rim of the case where these holes are placed, as the connectors must mount quite high for the PCB to clear the bottom of the case.

You'll also need to file flat the lip of the case lid where it would otherwise interfere with the XLR sockets.

Putting it all together

Now for the tricky part, shoe-horning the board into the case. It's a tight fit (deliberately!).

First, cut a sheet of *thin* insulating material (eg, cut from a PET milk bottle) and place it inside the base of the diecast box, to prevent the PCB from shorting to it. If there are any particularly sharp solder joints, you can put some electrical tape over them which will stop them from puncturing this insulating layer.

Next, temporarily remove the locking tab from the female (mic in) XLR socket by pressing it down and pulling it out.

Now feed the RCA socket through its hole in the side of the case. It's then a matter of rotating the PCB and pushing it down so as to get the XLR connectors into their holes. Don't force it; it's a very tight fit. You may even need to enlarge some of the holes in the case side before it will go in.

You may also find that you have to bend the XLR connectors a little so that their lip does not prevent that end of the board from sliding into place. Don't overdo it though as you could damage the PCB.

If the board doesn't want to go in, check that the corner cut-outs have been filed correctly and that it isn't hitting the bottom of the case, which suggests misaligned holes that will have to be enlarged further.

Once it pops in, fit the four screws to hold the XLR connectors in; this also holds the PCB in place and replace the XLR locking tab by pushing back in.

The diecast box provides best shielding against hum and so on if it is connected to the circuit ground. This normally occurs through contact between the shield of the 3.5mm or RCA connector but depending on how large you've made the holes, they may not make reliable contact.

In this case, the easiest solution is to replace one of the XLR mounting screws with an M2 x 10mm machine screw and nut and use this to attach a solder lug on the inside, under the nut.

You can then run a short wire from this lug to a convenient 0V point on the PCB below (eg, a resistor lead connected to ground). This is not critical but it's a good way to ensure that the shielding is most effective.

Before putting the lid on, connect the battery. The Li-Po cell can be attached under the lid with double-sided tape, in a position where it will clear the pots and LED. It's then just a matter of cutting out the four holes in the lid label, glueing it onto the lid, then screwing the lid on and the assembly is complete.

The mixer is now ready to use. SC

By Ian Batty

Anything you can do – Raytheon's T-2500 7-transistor radio

Raytheon's T-2500 (left) was considerably larger than the Regency TR-1 shown below and was a much better performer.

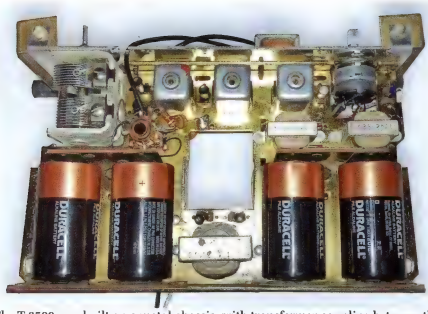
Electronics giant Raytheon (light of the gods) made it to market with their 8TP transistor radio just a few months after the first "trannie" – Regency's TR-1 (see April 2013). It was quickly followed by the T-2500. So was Raytheon's offering better?

TEXAS INSTRUMENTS, Raytheon and Tokyo Tsushin Kogyo (soon to become Sony) were among the front-runners in domestic transistor radio development. As a large, specialist manufacturer of military hardware and other high-tech products, Raytheon held an enviable position. The company pioneered sub-miniature valves and had developed a number of highly-specialised applications, such as proximity fuses for artillery shells.

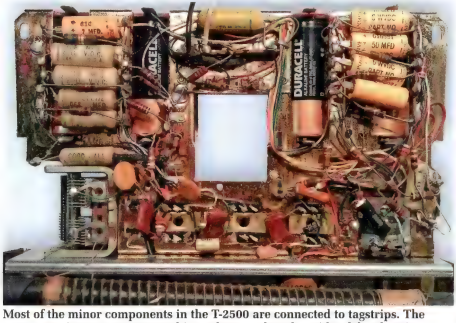
Raytheon's business was founded in 1922 by the redoubtable Vannevar Bush. The first electronic product marketed under the Raytheon brand was a 1925 cold-cathode helium gas rectifier used in "battery eliminators". Bush went on to administer the Manhattan Project (which developed the atomic bomb during WW2) and to invent "memex", an adjustable microfilm viewer with a structure that can now be compared to the World Wide Web.

The subsequent Apollo Guidance Computer that took Neil Armstrong and his crew to the Moon was a joint MIT-Raytheon project – "the most reliable computer of its time". Why, then, did the much smaller Texas Instruments, in partnership with the Regency Division of Industrial Development Engineering Associates, beat Raytheon to the transistor radio market, given the latter's outstanding manufacturing and engineering resources?

The reason for this was mainly due to the different types of transistors used by Texas Instruments and Raytheon in their early transistor radios. TI's laboratories had managed to bring the grown-junction technique to reality before Raytheon's alloyed-junction design. But although grown-junction



The T-2500 was built on a metal chassis, with transformer coupling between the various audio stages. Power came from four D-cell batteries.



Most of the minor components in the T-2500 are connected to tagstrips. The seven transistors were mounted in sockets on the other side of the chassis.

transistors were far superior to first-generation point-contact devices, they struggled to operate at broadcast radio frequencies.

In fact, the grown-junction transistor's limitations are confirmed by the Regency TR-1 being forced to use an IF (intermediate frequency) of only 262.5kHz. What's more, it required a 22.5V supply (close to the maximum rating) in order to operate at even this low frequency. In short, Regency's transistors did not have enough gain to operate at the standard 455kHz IF and from more normal supply voltages of 6-9V.

By contrast, Raytheon's engineers and scientists pinned their hopes on the newer alloyed-junction design. This was easier to manufacture and offered superior performance, as evidenced by the famous "CK" transistor types that the company developed.

Raytheon wanted to release a transistor radio that was at least as good as comparable valve portables. However, using the transistors of the day, this required six or more active stages.

Although the Regency TR-1's superhet design is electrically sound, its low gain, low power output and short battery life led one commentator to describe it as "a toy that didn't come at a toy price". However, Raytheon's initial offering was more ambitious. Designated the 8TP, it used the 8RT1 chassis design and boasted a total of eight transistors, used as follows: oscillator, mixer, two IF amplifiers, a detector, an audio driver and a push-pull audio output stage. It sold for $79.95, over half as much again as the cost of the TR-1 and the equivalent of around $683 today.

Ironically, the TR-1 had also initially been designed with eight transistors but an aggressive cost-cutting, "man overboard" program cut that down to four. In terms of value from money though, Raytheon's design was more than "one and a half times" better. Those extra transistors really made a big difference to the performance!

The 4-transistor TR-1 has a maximum sensitivity of about 500µV/m for a meagre 3mW output and its maximum audio output is just 6mW. By contrast, the 8TP's sensitivity for 3mW is easily 10 times better. And with its large speaker and 100mW push-pull output stage, the 8TP provides good listening levels, even against normal background conversation. The TR-1, however, demands "quiet room" conditions for comfortable listening.

Timber cabinet

Raytheon's 8TP was housed in a handsome timber cabinet with leatherette veneer and also featured brass knobs and brass or anodised trim. Power came from four "D" cells (giving a 6V supply) and the battery life was about 350 hours, compared to the TR-1's meagre 20 hours. The four "torch battery" cells in the 8TP cost about 60 cents in 1955, for a running cost of around 17 cents per hundred hours.

By contrast, the TR-1's 22.5V "hearing aid" battery cost about $1.25 and the running cost was around $6.25 per hundred hours. So it was no contest here either.

Following its release in March 1955, Raytheon's 8TP gained universal approval from reviewers, the only criticism being its large size although some reviewers also complained of low sensitivity. The sensitivity reservation is curious. Valve sets of the time were rarely much more sensitive. And a 1960 Mullard article refers to a 5-transistor portable (using the next generation of alloy-diffused transistors) with 200µV/m sensitivity as being

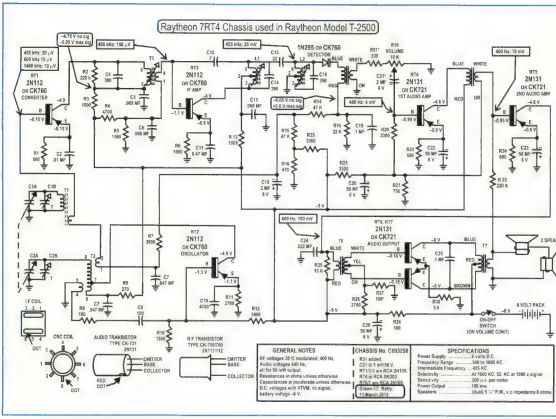


Fig.1: the circuit of the Raytheon T-2500 (7-RT4 chassis). It uses separate mixer and oscillator stages (RT1 & RT2), a single IF amplifier stage (RT3) and three transformer-coupled audio stages (RT4-RT7). The two transistors used in the output stage operate in push-pull and deliver up to 100mW.

"economical", adding that including an extra IF stage (for a sensitivity improvement of about 10 times to 20μV/m) would make it "outstanding".

AGC, IF stages & detector

The original 8RT1 chassis applied AGC to the two IF stages. The IF intercoupling technique used was perfectly standard, ie, a tapped, tuned primary matching to a low-impedance, untuned, untapped secondary.

This configuration allowed a high-Q IF-coil primary to match its driver transistor's medium-high output impedance. At the same time, the low-impedance secondary closely matched the following transistor's low input impedance.

The detector operated in class-B, working pretty much as a "diode with gain". Since it would conduct more heavily with signal, strong signals would force its collector voltage to fall. This collector voltage formed part of the bias network for the two IF amplifiers, thus providing AGC.

The 7RT1 chassis

The basic 8TP transistor radio went through several changes before being eventually discontinued. Raytheon then reworked the 8RT1 chassis design and released it as the 7-transistor 7RT1 while retaining the 8TP's case.

The 7RT1's chassis dispensed with one IF amplifier stage and the transistor detector but added an extra audio stage. This resulted in four transistors being used in the audio stages (ie, two audio amplifiers plus the push-pull output stage). Another two were used in the preceding RF/IF chain, while the seventh was used in the local oscillator.

The low signal from the 7RT1's diode detector was apparently unable to generate sufficient AGC to be applied to the remaining IF amplifier's base. As a result, the 7RT1 (unusually) uses AGC on the mixer. Because this changes the stage bias, and thus its collector current and input impedance, applying AGC to a single-transistor mixer-oscillator (as used in the TR-1 and most other transistor superhets) can cause unwanted oscillator frequency changes with changes in signal strength.

However, Raytheon's 7RT1 uses a separate oscillator design, so it is unaffected by AGC. Applying AGC directly to the mixer reduces overload due to strong signals in this stage and is quite effective.

Another unusual design aspect is that the 7RT1 uses transformer coupling between the detector diode and the first audio stage. This matches the detector to the low-input impedance of the audio stage and in fact, the entire audio section uses transformer-coupling between stages. While this gives the maximum possible power gain, it comes at the expense of extra transformers and their limitations on frequency response.

Negative feedback

Negative feedback is used in the audio stages, and is applied via a resistor connected from one side of the speaker pair to the base of the second audio driver stage. This helps reduce crossover distortion in the output stage, especially at low volume levels.

The three amplifying stages result in an audio sensitivity of about 4mV for 50mW output. This does, however, make the audio section somewhat noisy at low volumes.

T-2500 receiver

The 7RT1 chassis was used in the author's T-2500 set. With two 5.25-inch loudspeakers and a cabinet measuring some 310 x 150 x 230mm (including rubber feet), it's really about the size of a small car battery so it's hardly compact.

The T-2500's timber cabinet is soundly constructed and like the

The control knobs on the T-2500 are much too short to grip properly, making them fiddly to use.

TR8's, is covered in leatherette. The front and rear grilles are anodised expanded aluminium, with an anodised bezel for the front speakers. A cast enamelled badge and cast nameplate complete the front presentation.

The leatherette-covered carrying handle is attached via two brass screws and the cast-metal tuning and volume control knobs sit towards the top rear of the cabinet. The tuning and volume "zero" marks are provided by flat-topped, engraved brass screws. Being a US-made set, the dial has "Civil Defense" arrowheads at 620kHz and 1240kHz (as has my Regency TR-1).

The main chassis is cadmium plated and passivated steel, with aluminium brackets. Unlike the TR-1, with its printed circuit board, the T-2500 uses sockets for the transistors, tagstrips for the minor components and point-to-point wiring. The IF and audio transformers, the ferrite rod and the volume control have all been custom-designed to match the low transistor impedances but no other specialised components are used.

Basically, the standard of construction is excellent and Raytheon seems to have spared no expense to ensure a quality product.

T-2500 circuit details

Unlike Regency's TR-1, Raytheon's sets used conventionally-sized components, as used in the valve sets of the day. Raytheon's military equipment at the time was at the forefront of technology, a place it holds to this day.

Raytheon subsequently piloted the hobbyist use of transistors with the release of its famous CK722 germanium transistor, now fetching as much as $250 online. But while Regency obviously felt the simplicity of PCBs justified their development and production for its TR-1, Raytheon elected not to adopt this form construction for its T-2500, preferring instead to stick to hand-wiring and tagstrips.

Fig.1 shows the circuit details for the T-2500. Its RF/IF circuit is distinctive: a mixer with AGC applied, a separate oscillator stage that is unaffected by signal strength and a single IF amplifier stage.

The circuit voltages indicate that the mixer ("RT1") has virtually no base-emitter bias. That's because mixers must operate by swinging into cut-off (Class-B operation). The oscillator coil is air-cored, with no ferrite adjusting slug, and there's no oscillator adjustment at the low-frequency end of the broadcast band.

RT3 is the sole IF amplifier stage but there are three IF transformers – a carry-over from the 8RT1 with its two IF amplifiers. In this case, the "missing" second IF amplifier is replaced by a top-coupled "bandpass" circuit using two coils, each with a single tapped winding.

As in the Regency TR-1, the T-2500's IF amplifier uses neutralisation feedback (C12) to combat the regenerative effect of collector-base capacitance. A conventional diode detector follows the IF stage and the demodulated audio is then fed to the first audio stage via an audio transformer. The signal at the bottom of the primary of this transformer is also filtered to produce the AGC voltage and this is fed back to the mixer stage (RT1),

The detected audio is transformer-coupled to the first audio stage (RT4) via volume control R19 and this then drives the second audio amplifier stage (RT5) via another audio transformer. RT5 then drives the push-pull audio output stage (RT6 & RT7) via another audio transformer. This transformer has a centre-tapped secondary and acts as a phase splitter.

The push-pull output stage drives two series-connected speakers, again via a transformer, making four audio transformers in total.

The end of the line

With its four audio transformers, its cavernous case and dual 5.25-inch speakers, it's perhaps not surprising that the T-2500 was the end of the line for Raytheon's attempts to penetrate

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The T-2500's volume and tuning controls are mounted on the top of the cabinet and are awkward to use.

the domestic radio market. Raytheon also produced several smaller sets but even these were unable to create a sufficiently profitable line to continue production.

The T-2500 did leave one legacy, though. Moulded plastic cases are specialised items whereas timber cases are relatively easy to make, even at home. The *Radio, TV & Hobbies* "Transporta" series subsequently mimicked the Raytheon line with their generous timber cabinets and 5-inch speakers.

The author's T-2500

The author's Raytheon T-2500 (chassis number C093258) was purchased online for $375. Cosmetically, it was in very good condition, with acceptable wear on the case and no battery corrosion. A "506" date stamp on the tuning gang indicates that it was made in the sixth week of 1955.

The original 8TP's control layout on the top of the cabinet was carried over to the T-2500. These are awkward to use because the knob bosses are too short to grip properly. In addition, the small diameter of the calibrated dial ring on the tuning control does not indicate the station frequencies with any great accuracy.

The tuning does, however, have a slow-motion dial movement, which eases the task somewhat.

Despite this, the T-2500 is more difficult to tune than the TR-1. The latter's large dial face is easily read, it indicates frequencies more accurately and the dial can easily be used as a thumbwheel. The TR-1 also wins out on design. Its sleek, "post-deco" styling stands out, even today, from any number of anonymous transistor portables.

The T-2500's volume control is another drawback of the design. It has a slow onset, followed by a sudden increase in volume from about 90° of rotation. As a result, setting the required volume level can be rather fiddly.

Performance

The T-2500 easily meets its published specifications. Its sensitivity is 150μV/m at 600kHz for 50mW output, rising to 200μV/m at 1400kHz. The selectivity for 60dB signal attenuation is around ±30kHz at 600kHz and ±40kHz at 1400kHz.

The audio performance is modest by today's standard, with some 13% THD (total harmonic distortion) at the rated output of 100mW and a more respectable 4.6% THD at 50mW output. The frequency response of the audio stages (measured by feeding a signal into the volume control) is 230Hz to 2.3kHz. By contrast, a modulated RF signal fed into the aerial socket gives an overall frequency response (ie, for the entire receiver) of 580Hz to 2.3kHz.

Compared to the valve portables of the day, the T-2500 has similar audio fidelity but less than half the output power (ie, 100mW versus 250mW). However, this equates to a difference of just over 3dB which is hard to pick. The T-2500's sensitivity is equal to all but the best valve portables using RF stages.

As mentioned previously, the set's battery life (and thus its running cost) is excellent. At today's battery prices, the set costs just two cents an hour to run. And although I've not carelessly left it in the sun, I suspect that the T-2500's timber cabinet would survive such mistreatment much better than any plastic cabinet.

It may seem that I've been unduly harsh on some design aspects of the Raytheon T-2500. However, as an engineering design, it's an excellent performer, especially when judged by the standards of the day.

Schematic errors

Some corrections to Raytheon's original circuit schematic for the T-2500 should be noted. First, the detector diode was shown connected in reverse (the AGC would not operate if the detector was connected as shown in Raytheon's circuit). Second, the schematic also shows incorrect DC voltages for first audio stage based on RT4. The circuit diagram published here (Fig.1) is correct.

Finally, the Howard W. Sams "Photofact" (Set 329, Folder 11) also shows the detector connected in reverse. It also shows incorrect emitter and base voltages for mixer RT2. SC

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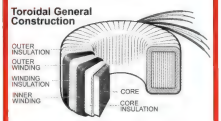

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PRODUCT SHOWCASE

Hakko FX-888 Soldering Station Goes Digital

It's been nearly four years since we reviewed the Hakko FX-888 soldering station (December 2009) and in that time it has earned an excellent reputation at every level from advanced hobbyist through technician and service and onto production lines.

Now Hakko, through their Australian agents HK Wentworth, have released a digital version, the FX-888D. Along with a heater output boost of 30% and better thermal recovery, the new model features a 3-digit LED display to accurately show soldering temperature. Instead of a dial to set temperature, it is now set by pushbuttons. Settings can be password-protected to avoid any "oopses" if someone changes a sensitive setup.

The small footprint of the FX888 (100 x 120mm) has been retained – in fact, the station appears to use a very similar case to the older model. And similarly, the FX-888D comes with a separate iron holder with cleaning sponge and wire.

The iron itself is very light – at 44g it's one of the lightest around. This augurs well for repetitive assembly line work. 16 different tips suit virtually all applications.

The separate tip/heater design also means easier (and cheaper) replacements when the time comes. This iron also supports the N_2 system which uses nitrogen gas to prevent oxidation and preheating, minimising bridging, soldering defects and component damage.

For more information on the Hakko FX-888D soldering station, visit Hakko's website: **www.hakko.com/english/products/hakko_fx888d.html**

Recommended retail is around $229.00

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Tel: (02) 9938 1566 **Fax:** (02) 9938 1467
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The new Tektronix PA4000 Power Analyser delivers consistently accurate measurements, even with challenging power waveforms.

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Tel: (02) 9911 3888 **Fax:** (02) 9418 8485
Website: www.tekmark.net.au

LabJack DIGIT-TL

Have an urge to measure the temperature in your refrigerator, attic, or car? The LabJack Digit-TL might be just what you need.

It's a battery-powered temperature logger which can store up to 260,000 readings and has a battery life of three years. It will record data in a wide variety of applications and download over USB (to .csv) using free Otero software for Windows.

The Digit-TL uses a Texas Instruments TMP112 to record temperature. The 12-bit readings are buffered on the chip and recorded to flash at every log event.

Unlike many battery powered loggers in its class, the Digit-TL user does not require a special base to download stored data.

The circuit board is protected by a thin film of conformal coating which makes the Digit-TL resistant to moisture, static discharges, and fingerprint oils. The Digit-TL comes with an IP68 rated enclosure.

Note that light readings will be stifled if the Digit-TL is inside of the enclosure. LabJack are working to provide a clear plastic enclosure but in the meantime it is advised to use a clear plastic baggy if light readings are important.

The price of the Labjack Digit-TL is $56.00 (+GST) direct from Ocean Controls.

Contact:
Ocean Controls
PO Box 2191, Seaford BC, Vic, 3198
Tel: (03) 9782 5882 **Fax:** (03) 9782 5517
Website: www.oceancontrols.com.au

LTE TV interference filter from Jaycar

When we told Jaycar Electronics about the Digital TV feature in this issue (see page 76) and the ramifications for existing TV antennas, they were quick to point out that they already stocked a filter designed specifically for eliminating interference from the new LTE (Long Term Evolution) or 4G services.

The Kingray LP-LTE25 filter is designed to insert into your TV antenna line, with "F" connectors on both input and output. It's a passive device so no power is required.

LTE rejection is claimed to be 25dB @ 750MHz. If you have a high-band UHF TV antenna after the Digital Switch-off, it may well receive 4G signals which can then interfere with digital TV reception in the lower channels.

The passband of this filter is from 5 to 694MHz. While it's intended for inside or protected use, it can be installed inside a protective cover for external operation.

Retail price is $24.95 (Cat No LT3061) and is available from all Jaycar stores, dealers or online.

Contact:
Jaycar Electronics (all stores)
PO Box 107, Rydalmere NSW 2116
Order Tel: 1800 022 888 **Fax:** (02) 8832 3188
Website: www.jaycar.com.au

SwannSmart Wi-Fi Network Camera with Secure Cloud Storage

A new wireless network monitoring solution from Swann Communications allows users to see and record what's happening on home or business security cameras via an existing wireless network with viewing on an iPhone, iPad or Android device – or indeed any 3G/4G device.

Called the SwannSmart it streams live video and images directly to secure cloud storage, to stream encrypted live video without needing to be connected to a computer.

Home and business owners can see and hear (via built-in microphone) what's happening during the day or in low light with infrared night vision up to 3.7 metres. It can be mounted on any flat surface, upside down and on ceilings and walls.

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There's a demo video at http://youtube/1zPIHcjHbSM

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PRINTED CIRCUIT BOARD TO SUIT PROJECT:	PUBLISHED:	PCB CODE:	Price:
DIGITAL LIGHTING CONTROLLER LED SLAVE	OCT 2011	16110111	$30.00
USB MIDIMATE	OCT 2011	23110111	$30.00
QUIZZICAL QUIZ GAME	OCT 2011	08110111	$30.00
ULTRA-LD MK3 PREAMP & REMOTE VOL CONTROL	NOV 2011	01111111	$30.00
ULTRA-LD MK3 INPUT SWITCHING MODULE	NOV 2011	01111112	$25.00
ULTRA-LD MK3 SWITCH MODULE	NOV 2011	01111113	$10.00
ZENER DIODE TESTER	NOV 2011	04111111	$20.00
MINIMAXIMITE	NOV 2011	07111111	$10.00
ADJUSTABLE REGULATED POWER SUPPLY	DEC 2011	18112111	$5.00
DIGITAL AUDIO DELAY	DEC 2011	01212111	$30.00
DIGITAL AUDIO DELAY Front & Rear Panels	DEC 2011	01212112P2/3	$20 per set
AM RADIO	JAN 2012	06101121	$10.00
STEREO AUDIO COMPRESSOR	JAN 2012	01201121	$30.00
STEREO AUDIO COMPRESSOR FRONT & REAR PANELS	JAN 2012	01201121P1/2	$20.00
3-INPUT AUDIO SELECTOR (SET OF 2 BOARDS)	JAN 2012	01101121/2	$30 per set
CRYSTAL DAC	FEB 2012	01102121	$20.00
SWITCHING REGULATOR	FEB 2012	18102121	$5.00
SEMTEST LOWER BOARD	MAR 2012	04103121	$40.00
SEMTEST UPPER BOARD	MAR 2012	04103122	$40.00
SEMTEST FRONT PANEL	MAR 2012	04103123	$75.00
INTERPLANETARY VOICE	MAR 2012	08102121	$10.00
12/24V 3-STAGE MPPT SOLAR CHARGER REV.A	MAR 2012	14102112	$20.00
SOFT START SUPPRESSOR	APR 2012	10104121	$10.00
RESISTANCE DECADE BOX	APR 2012	04104121	$20.00
RESISTANCE DECADE BOX PANEL/LID	APR 2012	04104122	$20.00
1.5kW INDUCTION MOTOR SPEED CONT. (New V2 PCB)	APR (DEC) 2012	10105122	$35.00
HIGH TEMPERATURE THERMOMETER MAIN PCB	MAY 2012	21105121	$30.00
HIGH TEMPERATURE THERMOMETER Front & Rear Panels	MAY 2012	21105122/3	$20 per set
MIX-IT!-4 CHANNEL MIXER	JUNE 2012	01106121	$20.00
PIC/AVR PROGRAMMING ADAPTOR BOARD	JUNE 2012	04105121	$25.00
CRAZY CRICKET/FREAKY FROG	JUNE 2012	08109121	$10.00
CAPACITANCE DECADE BOX	JULY 2012	04106121	$20.00
CAPACITANCE DECADE BOX PANEL/LID	JULY 2012	04106122	$20.00
WIDEBAND OXYGEN CONTROLLER MK2	JULY 2012	05106121	$20.00
WIDEBAND OXYGEN CONTROLLER MK2 DISPLAY BOARD	JULY 2012	05106122	$10.00
SOFT STARTER FOR POWER TOOLS	JULY 2012	10107121	$10.00
DRIVEWAY SENTRY MK2	AUG 2012	03107121	$20.00
MAINS TIMER	AUG 2012	10108121	$10.00
CURRENT ADAPTOR FOR SCOPES AND DMMS	AUG 2012	04108121	$20.00
USB VIRTUAL INSTRUMENT INTERFACE	SEPT 2012	24109121	$30.00
USB VIRTUAL INSTRUMENT INT. FRONT PANEL	SEPT 2012	24109122	$30.00
BARKING DOG BLASTER	SEPT 2012	25108121	$20.00
COLOUR MAXIMITE	SEPT 2012	07109121	$20.00
SOUND EFFECTS GENERATOR	SEPT 2012	09109121	$10.00
NICK-OFF PROXIMITY ALARM	OCT 2012	03110121	$5.00
DCC REVERSE LOOP CONTROLLER	OCT 2012	09110121	$10.00
LED MUSICOLOUR	NOV 2012	16110121	$25.00
LED MUSICOLOUR Front & Rear Panels	NOV 2012	16110121	$20 per set
CLASSIC-D CLASS D AMPLIFIER MODULE	NOV 2012	01108121	$30.00
CLASSIC-D 2 CHANNEL SPEAKER PROTECTOR	NOV 2012	01108122	$10.00
HIGH ENERGY ELECTRONIC IGNITION SYSTEM	DEC 2012	05110121	$10.00
USB POWER MONITOR	DEC 2012	04109121	$10.00
1.5kW INDUCTION MOTOR SPEED CONTROLLER (NEW V2 PCB)	DEC 2012	10105122	$35.00
THE CHAMPION PREAMP and 7W AUDIO AMP (one PCB)	JAN 2013	01109121/2	$10.00
GARBAGE/RECYCLING BIN REMINDER	JAN 2013	19111121	$10.00
2.5GHz DIGITAL FREQUENCY METER – MAIN BOARD	JAN 2013	04111121	$35.00
2.5GHz DIGITAL FREQUENCY METER – DISPLAY BOARD	JAN 2013	04111122	$15.00
2.5GHz DIGITAL FREQUENCY METER – FRONT PANEL	JAN 2013	04111123	$45.00
SEISMOGRAPH MK2	FEB 2013	21102131	$20.00
MOBILE PHONE RING EXTENDER	FEB 2013	12110121	$10.00
GPS 1PPS TIMEBASE	FEB 2013	04103131	$10.00
LED TORCH DRIVER	MAR 2013	16102131	$5.00
CLASSIC DAC MAIN PCB	APR 2013	01102131	$40.00
CLASSIC DAC FRONT & REAR PANEL PCBs	APR 2013	01102132/3	$30.00
GPS USB TIMEBASE	APR 2013	04104131	$15.00
LED LADYBIRD	APR 2013	08103131	$5.00
CLASSIC-D 12V to ±35V DC/DC CONVERTER	MAY 2013	11104131	$15.00
DO NOT DISTURB	MAY 2013	12104131	$10.00
LF/HF UP-CONVERTER	JUN 2013	07106131	$10.00
10-CHANNEL REMOTE CONTROL RECEIVER	JUN 2013	15106131	$15.00
IR-TO-455MHZ UHF TRANSCEIVER	JUN 2013	15106132	$7.50
"LUMP IN COAX" PORTABLE MIXER	JUN 2013	01106131	$15.00

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Send your email to silicon@siliconchip.com.au

Wideband AM tuner with variable selectivity

I have been surveying the radio broadcast landscape, trying to determine what sort of tuner I would like to either purchase or (preferably) build from a kit such as your illustrious team put out from time to time. What I see does not encourage me.

After a lot of searching around, I am inclined to think that DAB+ is not for me due to the aggressive limiting of the available bit rate, making the quality less than ideal as the broadcasters try to squeeze the most out of their allocated ensemble.

As you would be aware, being in the digital domain, the DAB+ system allows for multiplexing of several services on one system. DAB+ operates in VHF Band III which is also widely used for both analog and digital television broadcasts and from what I have seen and heard, the audio quality leaves a lot to be desired.

As you put it recently, "DAB+ quality is nowhere near as good as it could be because the stations simply do not have a high enough sampling rate".

It is self-evident that increasing the number of stations on any ensemble can only mean lower quality available audio. To cut to the chase, as a result of the above, I have decided I want to buy or build a wide-band AM tuner with the possible addition of a supplementary FM section.

As I live in Rosebud, out on the Melbourne broadcast fringe, I would need one that had switchable selectivity for listening in the evenings, to enable me to have a narrower band to enable better station separation. If that were not the case, then I would probably pick up all the splatter from along the east coast and have trouble with adjacent stations outside the "selected" 9kHz of my chosen station? It requires a 9kHz whistle filter and another feature I would like to possibly incorporate for similar reasons would be a 3-gang tuning capacitor with an added RF amplifier stage for better RF selectivity and sensitivity.

I imagine there would be a number of other listeners/readers in a similar situation as myself.

I am not an engineer so I only speak as an enthusiast who would like to have the opportunity to build a nice tuner to complement my hifi set-up and I think a good AM/FM tuner would do just nicely. After searching around, the best I can come up with is an ancient circuit from *Radio Television & Hobbies* from November 1953 which I found on the DVD I purchased from you recently: the 1953 Wide Band 7 but which would be no longer feasible due to scarcity of coils etc.

I would be interested in your thoughts on the idea. (B. T., Rosebud, Vic).

● The last wideband AM tuner described by SILICON CHIP was back in 1991 and it would now be virtually impossible to obtain all the components for it. In any case, we would not be inclined to bother since so few AM stations broadcast much music these days. You may be better off seeing if you can obtain a DAB+/FM radio which has stereo line outputs or headphone outputs. You can then couple that into your hifi system.

While the quality of DAB+ stations

Modifying A Positive-Chassis Tractor For The High-Energy Ignition

I have your ignition kit which I bought from Jaycar. On the bench, it works brilliantly. I want to put it on a 1953 Ferguson tractor but the problem is that it has the battery positive lead connected to the chassis. I think, by changing the connections to the generator, I could reverse the circuit and the kit could then be fitted normally. Or do you have a suggestion on how to fit the kit with reverse current flow?

I can't see how it would work with the diodes etc. But I know you guys are brilliant and you may have the answer. (T. C., via email).

● There are two ways to do this. One is to rewire the tractor for a negative earth. To assist in this, there are some Ferguson tractor wiring diagrams at **www.myfordtractors.com/12volt.shtml** Most early tractors have similar wiring.

As a guide, the terminals of the battery, generator, starter motor and ignition coil would need to have their polarity swapped. The regulator may also need changing or modifying. An auto-electrician could do this easily.

The second method would be to keep the positive earth wiring for the tractor and modify the ignition. We are not sure what ignition project you have as we have published many, but the basic idea will be the same. First, disconnect the negative connection of the high-energy ignition PCB from the case. Use a separate wire for the negative connection to the ignition switch. The positive supply for the high energy ignition goes to the the plus supply (ie, to the chassis + earth).

The ignition coil connects (unconventionally) between the ignition coil output on the high energy ignition (either the collector of the transistor or drain of the IGBT) and the positive earth chassis (with the ballast resistor in series if used).

Triggering via points will be inverted and so if you are using a high energy ignition with a microcontroller, then the triggering sense can be inverted.

Alternatively, for an older ignition that uses the MC334P ignition IC, a separate transistor inverting stage will need to be added.

is not as good as it could be, it is generally still quite good and much better than you will obtain from any currently available AM source (barring the Marantz NA7004 which is quite expensive).

DAB+ reception in Rosebud is likely to be marginal and you will need an external antenna.

5V supply needed for Leostick project

I have been developing a diesel engine effects/ESC module, intended for use in radio-control models. It uses a Leostick microcontroller, a CHAMP kit amplifier, daisy-chained Freetronics RGB LED modules and soon, an H-bridge motor-driver shield.

I ported the program from the BASIC Stamp article in Circuit Notebook of March 2006 issue into the Arduino sketch version and it seems to run well, with extra features added since. Some of the models I intend to use the module in have quite small battery cases, with supply voltages from 3V up to 4.5V. While I could modify the models to add a bigger battery pack and use a step-down PSU, the space becomes a problem and I am not sure the receiver in the small model would take extra voltage without damage.

I have read through the article in the March 2013 issue of your magazine on the AAA-Cell Torch Driver. It seems that this circuit may not be as pointless as it seems. It appears to be a nearly ideal step-up power supply to produce 5V from small battery packs for any Leostick projects, with the addition of a filter capacitor and a 5.1V zener diode, etc.

Would it be possible to re-design and publish it as a possible kit? (A. B., via email).

● The AAA LED Torch Driver chip is too specialised to make a good generic battery-powered boost converter. The circuit uses current regulation whereas you would want voltage regulation and the LED load doesn't change rapidly so the chip doesn't need good transient response and so on.

If your battery pack will always be at least 3V, then you could use an MC34063 in boost mode to generate a stable 5V supply. Also, the chip in the LeoStick (ATmega32U4) will run from 2.7-5.5V if you don't mind it operating at a maximum of 8MHz rather than 16MHz.

There are purpose-designed chips available to boost low battery voltages up to 3.3V/5V etc. Some of these will run off a single alkaline cell, down to 0.6-0.8V (depending on the model).

Problems With Connections To A PA System

The museum where I volunteer has a PA amplifier and speakers. An antiquated CD player feeds into it to play music but to solve the problem of the CD player being stereo and the PA amplifier mono, whoever connected them together just left the left channel unplugged. And to play the radio over the PA they just put the microphone next to the radio and turn them both on.

I thought it would work better if I connected a cheap mini hifi up to the PA. It would let us play radio, CDs and music on USB sticks.

The internet told me that I needed to make up a cable to go from from the two 4-ohm speaker outlets on the hifi through two 10kΩ resistors to the RCA input plug on the amplifier to reduce the signal level and combine left and right channels. That resistance value gave too little signal, so I tried 1kΩ, then 330Ω but it gave too much signal, so I went back to 1kΩ.

That worked but the sound that came out of the speakers connected to the PA amplifier was all bass with no treble to the point of being useless. It didn't appear to make much difference as to where I set the tone control on the PA amplifier. The mini hifi has no tone control.

Is what I'm trying to do fundamentally impossible for some reason or am I just doing it wrong? (G. D., via email).

● It is likely that the mini hifi's loudspeaker outputs need to be loaded by something close to a loudspeaker's normal resistance in order to work properly. You might try loading each channel output with say 16Ω 1W, as well as the feeder resistors to the PA amplifier.

Actually the problem you have with inputs to a PA is very common and coincidentally we have a project for just that application in this very issue, starting on page 72.

Resistance tolerance query for Semtest

I want to build the Semtest project designed by Jim Rowe (SILICON CHIP, February, March & May 2012). I know the component list said to use metal film resistors (1%) but can I use car-

Adapting the GPS Boat Computer To Aircraft

I purchased a kit for the GPS Boat Computer (SILICON CHIP, October 2010) in the hope that it may give me an alternative GPS data feed for my aircraft's electronics: Auto Pilot/EFIS as well as the Mode S Transponder. My usual source of this feed may have been overloaded as the data output line suddenly stopped working after running fine for a year or more, while the GPS unit itself is fine.

Do you know how many units that require a GPS data feed can be safely connected to the GPS unit's data output line before it has a detrimental effect on it? Is there some simple data amplifier that can be inserted into the pathway or perhaps a chip with the single GPS data feed input and say four separate outputs that then can be fed to separate devices without one effecting the other?

I need the standard position/altitude GPS data feed lines for all devices to work correctly. Can the GPS Boat Computer's USB data output feed line provide the necessary data line for all devices to work, or have I stuffed up in this respect? And if so, can you possibly suggest an output isolator/amplifier as described above that is capable of feeding the data reliably to four units, at least?

If the USB data output line is a no-go, can the signal be tapped from the GPS module itself, eg, where the data leaves the module, to go into the processor IC?

Can the different GPS outputs be selected somehow by using software, so that only the required data lines are actually sent, both for correct operation of the Boat Computer as well as the three or four feeds that are required for the aircraft systems? (G. K., Cobar, NSW).

● We asked the designer of the GPS Boat Computer, Geoff Graham, to reply to your questions:

On the question of how many units can be safely connected to the GPS unit's data output line, it would depend on the GPS unit concerned but it would be very unlikely that you damaged the GPS by overloading it. More likely, it was a simple component or cable failure.

You cannot use the USB output from the GPS Boat Computer to drive your equipment as that requires a computer to drive the USB protocol and as it does not have a serial output, it is unsuitable for your application.

You could simply use the EM-408 GPS module (from the Boat Computer kit) to drive your equipment. However, you will need to build a 3.3V power supply for the EM-408 and also an RS232 driver circuit to convert the TTL output from the EM-408 into RS232 (which I assume is required by your equipment).

Probably the best solution would be to purchase a GPS receiver with an RS232 output. There are quite a few on ebay with prices ranging from $50 to $150. One of these should be capable of easily driving three to four devices.

Editor's Note: the Deluxe GPS 1PPS Timebase (April 2013) has RS232 and USB outputs, and should be suitable. More inverter ICs could be used to provide multiple buffered outputs.

bon film resistors to save on money? I saw the circuit diagram showed 1% symbols next to some of the resistors. So is it safe to assume that I can use the rest that are not mentioned as 1% as 5% types? (R. M., via email).

● Yes, you can use 5% carbon film resistors in place of 1% metal film for all of the 0.5W resistors that are not shown as 1% on the circuit diagram.

Semtest high-voltage supply current question

I need a power supply capable of delivering approximately 100V at 40mA and I notice that the Semtest project described in the March 2012 issue has a high-voltage power supply. This is capable of delivering 100V when the correct resistor divider chain is selected but is it able to deliver 40mA?

If not, what modifications would be required to enable the power supply to deliver 40mA at the required 100V? (R. S., Burrill Lake, NSW).

● The DC-DC converter used in the SemTest project can deliver close to 40mA when set to produce a 100V output but you may need to reduce the value of the resistor connected between pins 6 & 7 of the MC34063 (IC1) from 0.27Ω to 0.22Ω (still 5W).

Increasing the rating of Power Tool Soft Starter

When using a 1.5kW demolition jack hammer with a 2kW generator, the start surge is considerable. Could you suggest changes to your July 2012 Soft Starter to dramatically increase its rating from 100W to 1500W? (D. K., via email).

● It should work as intended, in your application. The 100W rating refers to the minimum load. It will work with power tools rated up to 10A maximum and will limit inrush current to less than 20A. No changes should be necessary.

Furuno GPS may not be suitable

I have just finished building the GPS-based 10MHz Frequency Reference (SILICON CHIP, March & April 2007) and have a small issue that I was hoping you could help with. The unit I built seems to work fine without the GPS plugged in (except with no GPS data on display), however when the GPS module is plugged in, upon start-up the LCD flashes "UTC 00:00:00 FxO" around twice a second.

If I leave the GPS on, it does look like the GPS works, ie, 1Hz flash. There also appears to be data, looking at the Rx data on pin 7.

The GPS unit in question is a Furuno GN74 module as I could not get hold of a Garmin GPS15 and had this one on hand. All the data that I can find on the Furuno module indicates that it should be set at 4800 baud and sending data using the NMEA 1083 format, the same as the Garmin. Is this symptom a fault of the PIC or incorrect data from the GPS? Or is there something else I am missing? (S. B., via email).

● It's not possible to tell the exact cause of your problem, as we're not familiar with the Furuno GPS module.

But here are a few points to consider: first, it's usual for any GPS receiver module to take up to a minute or two to find a "fix" after switch-on and before a fix is achieved it may deliver "1 PPS" pulses but they won't be locked to the GPS system. Second, it's also usual for a GPS receiver module to not deliver any NMEA 0183 data stream until it has achieved a fix, so if a data stream is appearing this usually indicates that a fix has been achieved. Once the data stream appears, the 1 PPS pulses should also be present and locked to the GPS system.

Are you sure that your GPS receiver module is delivering its NMEA data stream at 4800 bps? The PIC and firmware in the GPS Frequency Reference will be expecting this bit rate and may not respond to a different rate. It might be worth feeding the data stream to your PC and viewing it with a software application to check it out.

Microphone relay circuit wanted

We run a small on-line radio station. We want our mic, once opened to speak, to activate the "on-air" light and as soon as its closed, to turn the light off again. This can be voice-activated as the mixer does not have mic on-off; only fade up-down. The XLR mic would have to be somehow connected to the mixer and then to the relay. (R. W., Eastbourne, UK).

● We published a Voice Operated Relay (or VOX) in July 2011. This triggers a relay when signal is detected. Signal level for triggering can range from microphone through to line level.

You can access a preview of the article on-line at **www.siliconchip.com.au/Issue/2011/July/Build+A+Voice-Activated+Relay+%28VOX%29**

Query over reference frequency

I am wondering why you have decided to step out of what I would see as the standard (10MHz) when it comes to frequency references. This is with respect to your recent 1 PPS frequency references.

World-wide, 10MHz has been the standard for a long time. I always would have thought 10MHz was a lot better for phase locking too and of course, a much smoother and more regular signal to track with the usual PLL circuits. (T. P., Molendinar, Qld).

● We have not "stepped away", to use your term. We produced the 1 PPS references to suit a particular application, ie, for calibration of the 12-Digit Frequency Counter. Have you seen our Frequency Reference in the March & April 2007 issues? It provides 10MHz and 1MHz references. It is quite a deal more complicated than the 1 PPS references.

You can access a preview of the first GPS 10MHz Frequency Reference article at: **www.siliconchip.com.au/Issue/2007/March/GPS-Based+Frequency+Reference%3B+Pt.1**

How to check farad capacitors

I am constructing a large variable-voltage power supply to deliver from around 12V at 240A to a maximum of 60V at around 70A. I am using four 3-farad capacitors across four separate power supplies that can be connected in various configurations to establish the above voltages and currents.

I have a curly one for you. I get some rather inconclusive results when measuring capacitors of one or more Farads. About the only thing I have not tried is to hook them up to a large amplifier via a known resistor and vary the frequency and measure voltages. In the past, this gave inconclusive results because of phase-shift problems.

Any suggestions? Or am I missing something? (B. F., via email).

● You could measure the impedance of the capacitor using the technique you suggest, driving the capacitor with an AC signal via a resistor and power amplifier, but this doesn't work too well with 1F capacitors since to have an impedance of 1Ω, the driving frequency required would be well below 1Hz at 159mHz. A lower frequency is required for a higher impedance. That is rather impractical without specialised equipment.

Perhaps the capacitance is best measured by measuring the time constant. This is the time taken for the capacitor to charge from zero to 63.2% of the supply via a resistor.

The time constant is R x C. So for a 1F capacitor and 100Ω resistor, the time constant is 100 seconds. Similarly, on discharge, the time constant is when the capacitor voltage reaches 36.8% of the supply from a fully charged state (ie, from the full power supply voltage across the capacitor).

For 1F supply capacitors, it is assumed that the equivalent series resistance (ESR) of the capacitor is well below 100Ω. However, that may not be true for some super capacitors that have a high ESR.

High-current AC supply wanted

I don't know if I am missing something or not but do you know how rare (or insanely expensive) a variable lab AC supply is? I have had several occasions recently when I needed to test something that required an AC supply that I did not have, eg, a vintage Atari 800 which needed a 9V 3A AC supply and I only had a 1A AC plugpack.

The only supplies I know of that are

Jacob's Ladder May Have Incorrect Dwell Setting

I have built the Jacob's Ladder project from the February 2013 issue. When I have lid off and apply power, the sparks seem to be happening with more intensity and frequency. When the case is assembled, the sparks are nowhere near as frequent and less intense.

Also how much current should it draw? The fused lead to the coil gets quite hot and I have measured over 10A, with the case lid off.

Also where can I get the source code to burn onto the microcontroller? I think I may have accidentally fried the PIC. (S. N., via email).

● There is possibly a breakdown in the wiring insulation between the coil output and the lid of the case. Check that the wire used is rated for 500V and that there aren't any nicks in the insulation.

The current shouldn't be as high as 10A. The dwell should be adjusted so that you have as much spark as required but without turning the dwell trimpot any further clockwise. Any further will only cause excess current flow without any extra spark energy.

The hex file for the microcontroller is available from **www.siliconchip.com.au** Click on "shop" and then "software".

Substitute For Oxy/Acetylene Welding

Your comments on "Brown's Gas" a little while ago are clearly correct and it would seem that the proponents of this idea in cars don't understand the law of conservation of energy.

I occasionally have a requirement for gas welding but paying around $100 a month for rental of two gas cylinders to sit in the corner is very poor economics. I wondered about the practicality of using an "on demand" electrolysis based system to supply hydrogen and oxygen, where the efficiency of the system is countered by the savings on cylinder rental, plus the convenience of not having to refill cylinders or store them. There appear to be commercially-available systems which use this method but they cost in the thousands and are much more powerful than I am contemplating.

I'd be interested in your comments and whether you think this might form the basis for a future magazine article. (B. D., via email).

● The real problem with electrolysis of water is that it is an energy intensive process, even if platinum electrodes are used. To produce enough gas for welding, you would need a large set-up. Remember that to run a welding gun you need the gases under pressure and that means that you have to generate a lot of gas.

To be practical, an electrolysis set-up would possibly need an electrical input power of many kilowatts. That is why commercial systems run into thousands of dollars.

Have you investigated oxy/LPG welding? That could be a cheaper option.

reasonably priced would be those intended for high-school classes which have combined AC and DC outlets (usually with incremental, not continuously variable output). If I am not missing something as to why these are not more common or cheaper, perhaps you could consider doing a kit for one.

I would suggest 5A capability at lower voltages and to whatever output voltage is considered safe or reasonable – maybe 100V (but not necessarily at 5A at that voltage). It should have voltage and current meters and overload protection. (D. B., via email).

● The reason that high-current variable AC supplies are so expensive it that the only practical way of doing it is to use a variac (VARiable AC). Those school supplies would be based on a multi-tapped transformer but if you wanted high current, again such a transformer would be expensive.

It would be possible to produce a design for a DC-to-AC converter with a variable sinewave output but it would not be simple or cheap.

Samsung TV has deflection circuit fault

I was wondering if you could help or perhaps let me know if I am wasting my time. I recently moved to the country and my 6-year-old Samsung 32-inch wide-screen CRT TV survived but while all else seems to work OK, the following fault is evident.

Instead of filling up the 16:9 screen nicely, the picture is distorted with a few inches of black screen either side and the picture disappearing top and bottom. The picture seems to be intact but squashed horizontally somewhat.

In order to have the set repaired, I would have to pay for transport 110km to and from the nearest major town. The TV weighs 50kg and would not fit in my car.

I know a little about TVs but not enough to attempt a repair beyond a minor adjustment. I know there are dangerous voltages inside the case. Does this sound like the yoke has moved? There are some small preset pots on circuit boards near the neck of the tube. Perhaps these need adjustment? Where would I look to get the service manual? (I. L., via email).

● We doubt if the yoke has moved or its adjustments have changed. You will find that the yoke is very solidly glued to the neck of the CRT and it would be very difficult to shift it. Nor is it likely that any of the presets need adjustment.

Instead, it seems likely that you have a fault in the horizontal deflection circuitry. You need to check around that section of the PCB for discoloured resistors or bulging capacitors. A semiconductor fault cannot be ruled out but is less likely.

To find the service manual, try doing a Google search with the brand and chassis number. That said, if you don't know what you are doing, leave it alone. A new LCD TV is really the way to go and you have a good excuse to ditch the old CRT set.

Extra features for 2.5GHz counter

Even though I was blown away by its features and performance (especially with a GPS frequency reference), I think the 2.5GHz 12-Digit Frequency Counter should have a pulse counter function fitted, like the one in my Aten F2700-C (Altronics Cat. Q1536). Is it possible to implement this feature with a PIC code change and minor hardware modifications?

Also, there should be DC blocking for Channel B (only Channel A has it) and maximum Vpp (voltage peak-to-peak) labelling for all inputs to help prevent accidental damage during use. (B. C., via email).

● Unfortunately your suggestions would involve more than just minor hardware modifications, especially the addition of a basic counting range. However, Channel B does have DC blocking via the 10nF input capacitor, albeit after the protection diodes on the input side. It would be possible to change the PCB slightly to get full DC blocking but any advantage would be doubtful, given the likely sources which might be used to drive it.

In any case, it would not be advisable to drive either input with much more than 1V RMS.

Digital Spirit Level is out of kilter

I have purchased a short-form kit of the Digital Spirit Level (Silicon Chip, August 2011) and built it. However, it doesn't perform as expected. The sleep/wake and zeroing functions work OK but when I rotate it from the horizontal to the vertical position it shows 90° at an actual angle of 45° and then just above this goes into four dashes. The article says it should do 360°.

Can you please throw any light on this problem? (P. R., via email).

● You apparently have the Digital Spirit Level with the latest version of the firmware, as described in Circuit Notebook, January 2012. This version

continued on page 96

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Ask SILICON CHIP

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has two read-out modes: percent gradient and degrees. In percent gradient mode, it will read 0-100 when rotated up to 45°, then just shows dashes above 45°. It sounds like your chip is in gradient mode.

To switch modes, hold down the calibration button for at least five seconds after it is switched on. It should then be in degrees mode and you can re-calibrate as necessary.

Capacitor discharge for points motors

The circuit diagram for the Capacitor Discharge Unit (SILICON CHIP, March 2013) indicates that it is suitable for both AC and DC power supplies. The unit apparently half-wave rectifies an AC supply, increasing the RMS voltage to peak voltage, thereby almost doubling its power potential.

By contrast, a DC current through the unit with no increase in voltage suffers voltage drops through the transistor and two diodes, making its power potential less than that of the AC power supply. It seems to me that the unit is not intended to be used with a DC power source. (J. M., via email).

- There is no problem with using AC or DC. We referred your email to the designer, Jeff Monegal, and his reply is below.

It should be remembered that although there is a silicon diode and the voltage drop across the transistor is in series between the power supply and the storage capacitors, there is very little current flow. In fact, forgetting leakage current through the capacitors, the only current flow is that though the LED – only around 9mA. This will mean very little voltage drop across the diode and transistor.

When either pushbutton is pressed, the coil of the point motor sees all of the voltage across the capacitor(s) minus the voltage drop across the output diode.

To say it seems that the CDU is meant for AC and not DC is incorrect because the CDU will work fine with DC. The Peco point motor we used operated well with a coil voltage of 12V DC. While it is true that a higher voltage will be available with AC power in, the point motor will operate fine with a DC voltage of around 15V or more.

I set up a CDU and obtained the following results:

- 15V DC gave 14.1V across the capacitors;
- 13V AC gave 15.4V across the capacitors; and
- 16.1V AC gave 18.9V across the capacitors.

These figures were with no load connected to the output. The only load was the LED (9mA). SC

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Notes & Errata

Digital Sound Effects Generator, September 2012: while the LM4889 was specified as an alternative to the LM4819 audio amplifier IC, we have discovered that the shutdown pin polarity of the LM4889 is opposite to that of the LM4819 (active low rather than active high). We recommend constructors stick with the LM4819.

1W LED Driver With Protection, Circuit Notebook, May 2013: the second and third paragraphs in the third column should say "With an open circuit, the voltage across the 220µF capacitor can become as high as the supply, damaging the LEDs should they be reconnected with this higher voltage present. With the protection circuit, a higher than normal voltage allows ZD1 to conduct, pulling pin 5 of IC2b higher than its inverting input. This occurs with about 1mA through ZD1 and 1V across each 1kΩ resistor. So there is about 10.2V across the 220µF capacitor".

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